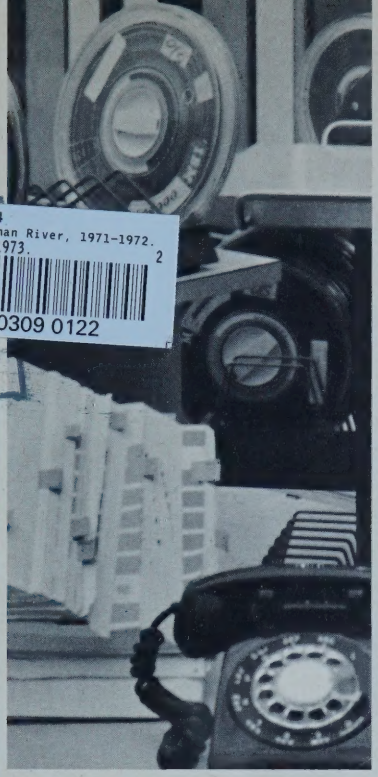
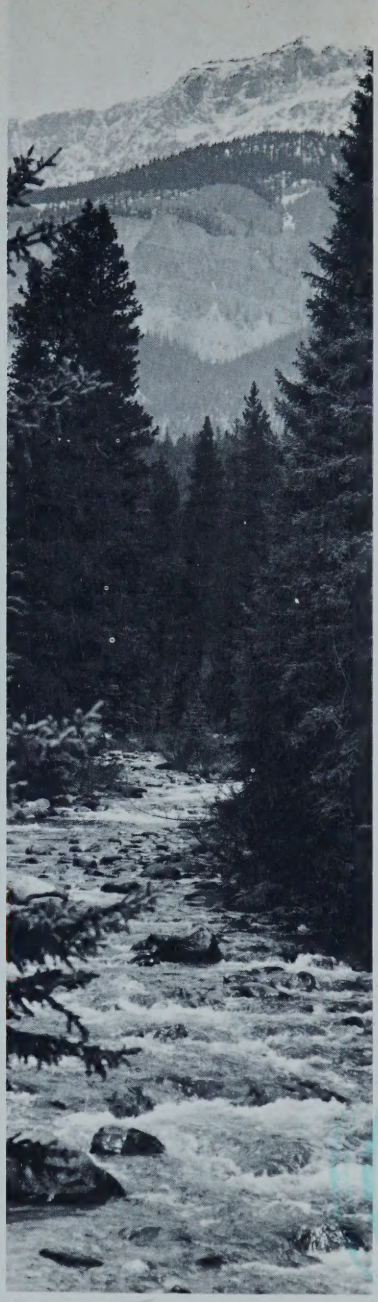
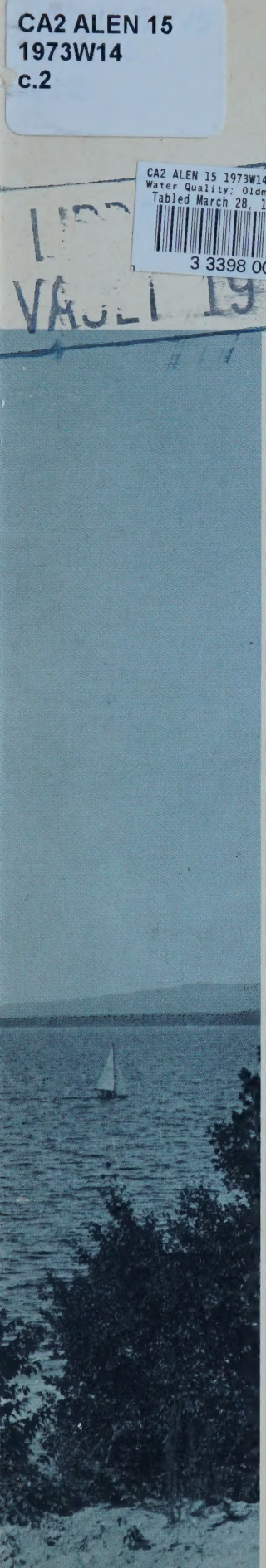
CA2 ALEN 15
1973W14
c.2

CA2 ALEN 15 1973W14
Water Quality; Oldman River, 1971-1972.
Tabled March 28, 1973.
2
3 3398 00309 0122







alberta
department
of the
environment

HON. W. J. YURKO, MINISTER

DR. E. E. BALLANTYNE, DEPUTY MINISTER

MAR 1973
C-2
EDMONTON

SESSIONAL PAPER 524

WATER QUALITY
OLDMAN RIVER

TABLED MARCH 28/73.

1971-1972

POLLUTION CONTROL
DIVISION

Digitized by the Internet Archive
in 2026 with funding from
Legislative Assembly of Alberta - Alberta Legislature Library

LIBRARY
VAULT 19

SESSIONAL PAPER 524
TABLED MARCH 27/73.

WATER QUALITY

OLDMAN RIVER

1971-1972

Digitized by the Internet Archive
in 2026 with funding from
University of Alberta Library

https://archive.org/details/ableg_33398003090122

WATER QUALITY

OLDMAN RIVER

1971 - 1972

BY

P. KONOPASEK, P.ENG.

PROVINCE OF ALBERTA

DEPARTMENT OF THE ENVIRONMENT

DIVISION OF POLLUTION CONTROL

6TH FLOOR MILNER BUILDING, EDMONTON

A B S T R A C T

Water quality surveys of the Oldman River were conducted during the months of November through March for the winter of 1971-1972. To evaluate the loadings into the river, the analyses of industrial and municipal discharges were also performed.

The flow rate in the Oldman River during the 1971-1972 hydrological year was higher than the rate during the past fifteen years.

In spite of increased loadings from the last season survey, the water quality is within satisfactory limits. Significant improvement was observed in Dissolved Oxygen, Oil and Grease, and Threshold Odor Number. This improvement is due to the new secondary sewage treatment facilities at Lethbridge and to the higher flow rates. In general, there is no serious problem with water quality in the Oldman River, but the high Mercury levels warrant more detailed analyses in future surveys.

TABLE OF CONTENTS

ABSTRACT i

TABLE OF CONTENTS iii

ESTABLISHMENT AND OPERATION OF THE PROGRAM v

SAMPLING STATIONS AND PROCEDURES vii

INTRODUCTION 1

DISCUSSION 2

- MONITORING PROGRAM 2
- HYDROMETRIC DATA 2
- LOADINGS TO THE OLDMAN RIVER 4
- DISSOLVED OXYGEN 5
- BIOCHEMICAL OXYGEN DEMAND 6
- NUTRIENTS 6
- THRESHOLD ODOR NUMBER 8
- PHENOLIC MATERIAL 8
- OIL AND GREASE 8
- HEAVY METALS 8
- BACTERIOLOGICAL CONSTITUENTS 10

SUMMARY 10

ESTABLISHMENT AND OPERATION OF THE PROGRAM

Many of the problems involved in the establishment and operation of the program are of practical rather than technical consideration. A summary discussion of some of the more basic considerations has been included.

PROGRAM OBJECTIVES

This program was established a number of years ago to provide basic information which would reveal pollution trends and provide water quality data for the many existing and prospective users of surface water in Alberta.

The monitoring program has these specific objectives:

1. To determine the chemical, physical, bacteriological and biological characteristics of Alberta's water under changing conditions.

2. To indicate, when possible, the sources of pollution entering a stream.

3. To compile data for future pollution abatement activities.

4. To determine background data on certain types of wastes and to detect critical changes.

5. To obtain data useful for municipal, industrial, agricultural and recreational uses.

6. To procure data useful and necessary for securing public action toward the preservation of streams for all beneficial uses.

SCOPE OF ANALYSES

The frequency of sampling is admittedly limited. In some instances a more important parameter such as dissolved oxygen is monitored continuously. The routine analyses shown in this report represent the minimum of bacteriological, biochemical and chemical analyses which justify the program.

SAMPLING STATIONS AND PROCEDURES

The following criteria were used as a basis for the selection of monitor stations:

1. Waters used for municipal, industrial, agricultural, and recreational purposes.
2. Near known or suspected sources of pollution.
3. Near the Alberta-Saskatchewan border to determine the quality of water leaving the province.

Stations were established at bridges whenever practical for convenient access to each watercourse. Routine samples included two litres for general chemical analyses, one litre each for Phenolics and Oil and Grease, and 100 millilitres in a sterile bottle for bacteriological analyses. Four litre samples were collected in a pyrex glass jar for Heavy Metals analysis.

INTRODUCTION

The Oldman River and its tributaries serve as a source and a receiving stream of irrigation water for several major irrigation districts in southern Alberta. Aside from irrigation, the Oldman River water is used for domestic, recreational, and industrial purposes. The total watershed area is 9,270 square miles with a mean annual runoff of 2,500,000 Ac-ft.

Water quality monitoring of the Oldman River was established several years ago to indicate the sources of pollution and to provide information which would reveal pollution trends for the planning of new treatment programs and facilities for industries and municipalities.

The purpose of this report is to summarize the water quality survey during the winter months of 1971-1972.

DISCUSSION

MONITORING PROGRAM

Sampling surveys have been conducted on five locations at the Oldman River and on one location at Drywood Creek. Sampling locations are shown on Figure 1 and are listed in the following Table:

TABLE NO. 1

Name	Location	Number of Samples Taken
DR 1 Drywood Creek	Gulf Gas Plant	4
OR 1 OR above Lethbridge	City Power Plant	6
OR 2 OR above Picture Butte	South of Picture Butte	2
OR 3 OR below Picture Butte	Nolan Bridge	6
OR 4 OR above Taber	Provincial Park	6
OR 5 OR below Taber	Highway 36 Bridge	6

The locations were selected to monitor only major sources of pollution from the oil industry, sugar factories, and municipalities. For economic and technical reasons, the sampling was carried out only during the winter months and at a limited number of locations.

HYDROMETRIC DATA

There are available hydrometric data from three stations on the Oldman River and from two stations on Drywood Creek. However, only the data from Station No. 05AD007 (Oldman River near Lethbridge) and Station No. 05AD010 (Drywood Creek near the Mouth) have some relation

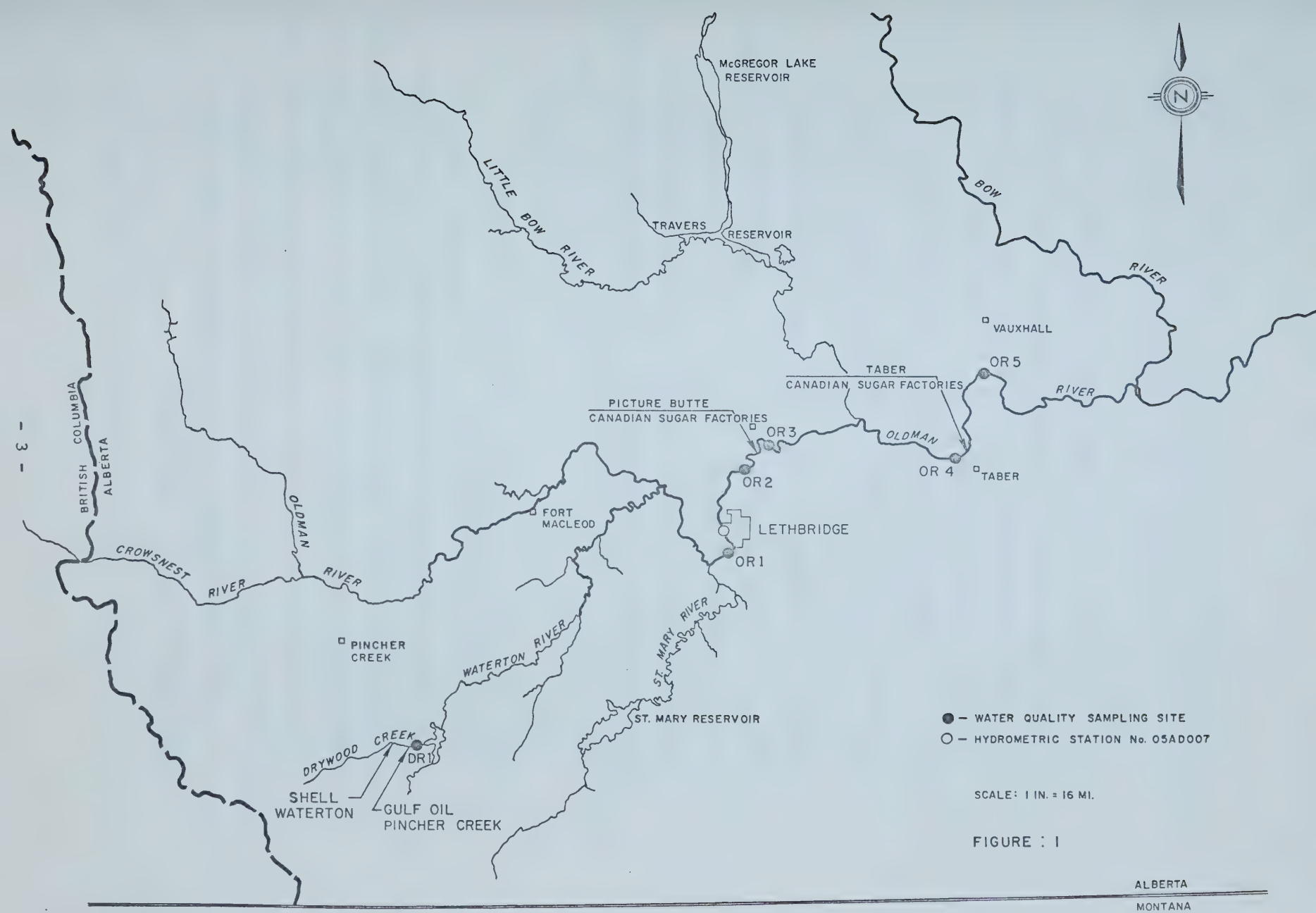

McGREGOR LAKE RESERVOIR
LITTLE BOW RIVER
TRAVERS RESERVOIR
BOW RIVER
N
VAUXHALL
TABER
CANADIAN SUGAR FACTORIES
OR 5
RIVER
PICTURE BUTTE
CANADIAN SUGAR FACTORIES
OR 3
OLDMAN
OR 4
TABER
OR 2
FORT MACLEOD
LETHBRIDGE
OR 1
BRITISH COLUMBIA
ALBERTA
CROWSNEST RIVER
OLDMAN RIVER
PINCHER CREEK
WATERTON RIVER
ST. MARY RIVER
ST. MARY RESERVOIR
DRYWOOD CREEK
DR 1
SHELL WATERTON
GULF OIL PINCHER CREEK
● — WATER QUALITY SAMPLING SITE
○ — HYDROMETRIC STATION No. 05AD007
SCALE: 1 IN. = 16 MI.
ALBERTA
MONTANA

FIGURE : 1

to the sampling locations and so the data from these stations are used to determine the pollutant loadings to the Oldman River in this report.

Daily flows in the Oldman River near Lethbridge (Station No. 05AD007) for the period of October, 1971 through March, 1972 are presented in Plate No. A-1. The minimum daily discharge rate was 182 c.f.s. recorded on December 9, 1971.

Ice conditions on the Oldman River at Lethbridge began on November 19, 1971 and lasted till March 12, 1972.

Frequency distributions of river flows at Lethbridge for the period 1957 to March, 1972 and for the survey year 1971 (April, 1971 - March, 1972) are presented in Plate No. A-2. The discharge rate during the survey year for frequencies of occurrence up to 30% and from 70% to 90% shows an increase as compared to the 1957-1972 flow frequency distribution. These increases can be attributed to additional releases to water during the critical winter period and to precipitation, respectively.

LOADINGS TO THE OLDMAN RIVER

Major contributors of wastes discharged to the Oldman River are in the Lethbridge area. These are the municipal wastes from Lethbridge and the sugar factories located at Taber and Picture Butte. Plate No. A-4 in Appendix A of this report presents the users of Oldman River for discharge of waste water. The types of treatment are also included.

The total loadings of various pollutants for each survey are tabulated in Plate A-5 of Appendix A.

The following Table lists the minimum, mean and maximum loadings of six constituents during the winter survey:

TABLE NO. 2

CONSTITUENT	LOADINGS (lbs/day)		
	MINIMUM	MEAN	MAXIMUM
BIOCHEMICAL OXYGEN DEMAND (5-day, 20°C)	3,935	35,164	71,506
CHEMICAL OXYGEN DEMAND	4,850	60,475	114,795
OIL AND GREASE	633	2,818	4,880
PHENOLICS	0.3	2.3	6.4
TOTAL PHOSPHOROUS	507	1,615	2,799
AMMONIA NITROGEN	1,045	2,696	6,130

DISSOLVED OXYGEN

Biological degradation of organic matter by bacteria results in an oxygen depression in the river, particularly during the winter when ice cover prevents re-aeration. Testing for Dissolved Oxygen at various locations in the river provides means for assessing this rate of bio-degradation and provides an index for the performance of the river.

Dissolved Oxygen in the Oldman River during the critical winter period was considerably higher than the values recorded in the previous year. This was primarily due to commencement of the secondary treatment facilities at Lethbridge treatment plant and due to above average discharge rate in the river and its tributaries. The minimum value for

Dissolved Oxygen during the winter of 1971-1972 was 7.5 mg/l monitored at the Below Taber site on January 19, 1972 (last season's minimum was 3.6 mg/l on January 27, 1971 at the same site). River profiles of Dissolved Oxygen are presented in the Appendix.

BIOCHEMICAL OXYGEN DEMAND

The amount of oxygen consumed in stabilizing waste material is determined by the Biochemical Oxygen Demand tests. Oxygen demand in surface water is exerted by three classes of material: Carbonaceous organic material available as food for micro-organisms, nitrogenous material susceptible to microbial oxidation, and chemical reducing agents. Biochemical Oxygen Demand indicates the rate at which biodegradable organic material is being assimilated in the water.

The background level of Biochemical Oxygen Demand varied from 0.8 mg/l to 1.6 mg/l at the Above Lethbridge location. Values downstream from Lethbridge varied between 1.8 mg/l to 2.9 mg/l. The maximum recorded value was 5.8 mg/l at the Below Taber location on November 9, 1971. This high value was primarily caused by effluents from sugar factories. The Biochemical Oxygen Demand did not exceed a limit which would create a dissolved oxygen content of less than 5.0 mg/l in any sample taken during the survey.

NUTRIENTS

The presence of external sources of nutrients in the Oldman River tends to increase the fertility of the river and algae growths may occur. Three nutrient groups are summarized below.

Ammonia Nitrogen

Ammonia Nitrogen values ranged from a low of less than 0.1 mg/l to a high of 1.7 mg/l (Oldman River Above Taber, March 22, 1972). The average Ammonia Nitrogen values were 0.21 mg/l at Above Lethbridge, 0.25 mg/l at Above Picture Butte, 0.53 mg/l at Below Picture Butte, 0.58 mg/l at Above Taber and 0.38 mg/l at Below Taber. On Drywood Creek an average of 0.12 mg/l was observed. The averages indicate slightly higher Ammonia Nitrogen concentrations present than in the previous year's survey. The maximum, median and minimum are shown in Appendix A.

Nitrate-Nitrite Nitrogen

Nitrate-Nitrite Nitrogen values ranged from a low of zero to a maximum of 0.5 mg/l at Below Taber (March 22, 1972). The average Nitrate-Nitrite Nitrogen values were 0.13 mg/l at Above Lethbridge, 0.20 mg/l at Above Picture Butte, 0.21 mg/l at Below Picture Butte, 0.20 mg/l at Above Taber and 0.17 mg/l at Below Taber. On Drywood Creek the Nitrate-Nitrite Nitrogen values ranged from zero to 0.4 mg/l and averaged 0.17 mg/l. The data is plotted in Appendix A.

Total Phosphorous

The values of Total Phosphorous ranged from 0.05 mg/l at Above Lethbridge to a maximum of 1.00 mg/l recorded at Below Taber site on March 22, 1972. On Drywood Creek the Total Phosphorous value did not exceed the water quality standard value of 0.15 mg/l. The values are slightly higher than in the previous year's survey. The maximum, median and minimum are indicated in Appendix A.

THRESHOLD ODOR NUMBER

The water quality criteria maximum odor number of eight was not exceeded during the sampling season. However, an odor number of eight was obtained once on November 9, 1971 at Below Taber site.

PHENOLIC MATERIAL

The presence of Phenolics in a river is objectionable because of its toxicity to fish at high concentrations and the unpleasant taste and odors in drinking water supply systems at concentrations of less than 5 p.p.b. when raw water containing Phenolics is chlorinated.

Phenolics concentration in the Oldman River varied from zero to 10 p.p.b. A comparison to last year's data indicates a decreasing trend.

OIL AND GREASE

Potential contributors of oil and grease in surface waters can all be agencies engaged in the production, transportation, handling and use of petroleum products. In natural waters, the oily substance may be due to the decomposition of plankton or other organic materials. Water flowing through an oil-bearing stratum would also add to the natural background level of oil and grease in the water.

The maximum value measured during the 1971-1972 winter survey was 1.5 mg/l at Above Lethbridge site on October 20, 1971. All maximum and average values indicated a substantial decrease in this pollutant concentration when compared to last year's values.

HEAVY METALS

Metals in surface waters are of serious concern because of their

possible toxic properties. During the 1971-1972 season, four surveys for Heavy Metals were completed on the Oldman River and two surveys on Drywood Creek. Analyses were run for Arsenic, Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Mercury, Nickel, Selenium and Zinc.

The Heavy Metal concentrations in samples taken at the Gulf Gas Plant site on Drywood Creek were within the Surface Water Quality Standards, but Mercury exceeded the maximum permissible concentration of 0.0001 mg/l in two samples. The concentration of Arsenic, Chromium, Lead and Selenium did not exceed the maximum permissible concentration in any sample taken during this survey.

Cadmium

The maximum value of 0.040 mg/l was observed at the Below Taber sampling location on December 1, 1971. The maximum permissible concentration for this constituent is 0.01 mg/l.

Copper

Only one Copper value of 0.021 mg/l was slightly higher than the water quality standard value of 0.02 mg/l.

Manganese

Sixteen samples were analyzed for Manganese, of which four exceeded the water quality standard value of 0.05 mg/l. The maximum value of 0.16 mg/l was recorded at Below Taber site on March 22, 1972.

Mercury

All of the sixteen analytical tests for Mercury exceeded the maximum permissible concentration of 0.0001 mg/l. Due to instrumentation limitation, the lower detection limit of Mercury was limited to 0.0005 mg/l. The maximum value of 0.0065 mg/l during this survey was recorded at Above Taber site on December 1, 1971.

Zinc

The maximum permissible surface water quality concentration of 0.05 mg/l for Zinc was exceeded in four out of sixteen tests. The maximum of 0.118 mg/l was recorded at Below Taber site on December 1, 1971.

Other Metals

The maximum Cobalt value of 0.009 mg/l was recorded at Above Taber site on March 22, 1972 and the maximum Nickel value of 0.023 mg/l was recorded at Below Taber site on December 1, 1971 during the 1971-72 winter survey. The maximum permissible concentrations for Cobalt and Nickel are not stated in the Surface Water Quality Standards.

BACTERIOLOGICAL CONSTITUENTS

Bacteriological Constituents measured during this year's survey included Most Probable Number (MPN) of Total Coliform, MPN of Faecal Coliform and Standard Plate Count bacterial density. All Coliform samples registered values within the Surface Water Quality Standards. The MPN Total Coliform ranged from 5 to 1800 organisms/ 100 ml and the MPN Faecal Coliform ranged from zero to 130 organisms/ 100 ml measured at Below Picture Butte site on January 19, 1972. Standard Plate Count ranged from 500 to 325,000 colonies/ml.

SUMMARY

There is no serious problem with water quality in the Oldman River.

Dissolved Oxygen, Oil and Grease, and Bacteriological Constituents

measured in the Oldman River indicated satisfactory values. Nutrient levels were slightly higher compared with those of the previous survey. Among Heavy Metals, the Mercury levels are significantly above the Surface Water Quality Standard limit.

GLOSSARY

WATER POLLUTION CONTROL TECHNOLOGY

This is a selected list containing the key terms likely to be encountered in water pollution control technology.

ABSORPTION - The taking up of one substance into the body of another.

ACID - Most commonly refers to a large class of chemicals having a sour taste in water, ability to dissolve certain metals, bases or alkalies to form salts and to turn certain acid-base indicators to their acid form. Characterized by the hydrated H^+ ion.

ADSORPTION - The taking up of one substance upon the surface or interface zone of another substance.

ADVANCED WASTE TREATMENT - Renovation of used water by biological, chemical or physical methods that are applied to upgrade water quality for specific re-use requirements. May include more efficient cleanup of a general nature or the removal of components that are inefficiently removed by conventional treatment processes.

AERATION - The operation of adding oxygen to, removing volatile constituents from, or mixing a liquid by intimate contact with air.

AEROBIC - A condition characterized by an excess of dissolved oxygen in the aquatic environment.

AEROBIC BACTERIA - Organisms that require dissolved oxygen in the aquatic environment to enable them to metabolize or to grow.

ALGAE - Primitive plants, one or many celled, usually aquatic and capable of growth on mineral materials via energy from the sun and the green coloring material, chlorophyll. Generally considered as the primary source of food for all other organisms.

ALKALINITY - A term used to represent the sum of the effects opposite in reaction to acids in water. Usually due to carbonates, bicarbonates, and hydroxides; also including borates, silicates and phosphates.

ANAEROBIC - A condition in which dissolved oxygen is not detectable in the aquatic environment. Commonly characterized by the formation of reduced sulfur compounds from the use of bound oxygen from sulfates as a hydrogen acceptor.

ANAEROBIC BACTERIA - Organisms that can metabolize and grow in the absence of dissolved oxygen. Their oxygen supply is obtained from the bound oxygen such as in sulfates, carbonates, or other oxygen-containing compounds.

ANION - A negatively charged ion in water solution. May be a single element or a combination of elements, such as the Cl^- ion in a water solution of NaCl (common table salt) or $SO_4^=$ ion in a sulfuric acid solution.

ASSESSMENT - A legal financial obligation of the property owner in an irrigation, water, drainage or sanitary district, created for the purpose of financing the construction and operation of facilities required to protect and enhance public benefit within the district.

BACTERIA - Primitive organisms having some of the features of plants and animals. Generally included among the fungi. Usually do not contain chlorophyll, hence commonly require preformed organic nutrients among their foods. May exist as single cells, groups, filaments, or colonies.

BENTHIC DEPOSIT (BENTHOS) - Refers to the accumulated deposition of cell mass living or dead that collects at the bottom of a stream impoundment where velocity or catchment permits.

BIO-CHEMICAL - Resulting from the combined activities of biological and chemical transformations. Usually measured in terms of the ensuing chemical changes.

BIODEGRADATION - The stabilization of waste water contaminants by biological conversion of pollutants into separable materials at a higher oxidation state.

BIOLOGICAL PROCESSES - Activities of living organisms to sustain life, growth, and reproduction. Commonly the processes by which organisms degrade complex organic material into simpler substances at a higher oxidation state to obtain energy for life processes and growth of new cell mass.

B.O.D. - Biological or biochemical oxygen demand. A test for estimation of waste water polluting effects in terms of the oxygen requirements for biochemical stabilization under specified conditions and time.

BUFFER ACTION - An action exhibited by certain chemicals that limits the change in pH upon addition of acid or alkaline materials to the system. In surface water, the primary buffer action is related to carbon dioxide, bicarbonate and carbonate equilibria.

CARBOHYDRATES - Naturally occuring compounds consisting of carbon, hydrogen, and oxygen, that are considered as energy foods and precursors of proteins and fats in the natural food chain.

CATION - A positively charged ion in water solution. May be a single element or a combination of elements, such as Na^+ in a water solution of NaCl (common table salt).

CHLOROPHYLL - The green coloring material or pigments in plants that promote the photosynthetic reactions forming organic materials from inorganic nutrients and light energy within the living cells.

CLARIFIER - A basin or chamber serving as an enlargement of a channel to reduce flow velocity sufficiently to permit separation of settleable or floatable materials from the carrier water (a sedimentation basin).

COAGULANT - A chemical, or chemicals, which when added to water suspensions will cause finely dispersed materials to gather into larger masses of improved filterability, settleability, or drainability.

COAGULATION - The process of modifying chemical, physical, or biological conditions to cause flocculation or agglomeration of particulates.

C.O.D. - A test for the estimation of the contamination of a waste water in terms of oxygen requirements from a strong chemical oxidant under specified conditions, i.e., Dichromate, 50% sulfuric acid and 145°C for two hours.

COLIFORM GROUP - A group of bacteria that inhabits the intestinal tracts of man, warm-blooded animals, and may be found in plants, soil, air, and the aquatic environment. Includes aerobic and facultative gram negative non-spore forming bacilli that ferment lactose with gas formation.

COLLOID, COLLOIDAL STATE - A state of suspension in which the particulate or insoluble material is in a finely divided form that remains dispersed in the liquid for extended time periods. Usually cloudy or turbid suspensions requiring flocculation before clarification.

CONCENTRATION -

a) The act of increasing the mass per unit volume of one substance with respect to another, such as concentrating the solids in a sludge from 3% to 6%.

b) A means of designating the ratio of one substance with respect to another, such as 15 mg of suspended solids per liter of water.

CRITERION (pl. CRITERIA) - Something which can be measured. Commonly used as a basis for standards.

CUBIC FOOT PER SECOND (c.f.s.) - A unit of discharge rate such as one cubic foot of water per second past a given point.

DATA - Records of observations or measurements of facts, occurrences and conditions in written, graphical or tabular form.

DEGRADE - To reduce the complexity of a chemical compound.

DENITRIFICATION -

a) The conversion of oxidized nitrogen (nitrate and nitrite-N) to nitrogen gas by contact with septic waste water solids or other reducing chemicals.

b) A reduction process with respect to oxidized nitrogen.

DETERGENT - Something used for cleaning. Commonly consists of soap or surfactant plus various additives or associated materials.

DILUTION -

a) To make thinner or more liquid.

b) A ratio, volume, or weight or a more concentrated sample or effluent flow compared to that into which it is discharged.

DISSOLVED -

a) Those materials dispersed in water in ionic, atomic, or molecular form; an homogenous mixture or solution.

b) Generally clear but may be colored.

c) Present in true solution form.

DISSOLVED OXYGEN (D.O.) - Dissolved molecular oxygen usually expressed in mg DO/l or percent of saturation.

ECOLOGY - The relation of an organism to its environment, i.e. how an organisms is affected by its surroundings such as air, water, heat, noise, contamination, etc.

EFFLUENT - A liquid or product water discharged from a chamber, basin, or other treatment operation.

ENTERIC ORGANISMS - Those organisms commonly associated with the intestinal tract.

ENTRAINMENT - A condition or action that will cause an immiscible substance to be mixed with another. Usually the result of turbulence or entrapment, i.e., air bubbles in aqueous media.

ENZYME - A soluble or colloidal organic catalyst produced by a living organism. Usually they are simple or conjugated proteins that catalyze specific reactions.

EUTROPHIC - Well nourished; rich in dissolved nutrients.

EUTROPHICATION - An action involving the aging of lakes characterized by nutrient enrichment and increasing growth of plant and animal organisms. The net effect is to decrease depth until the lake becomes a bog and eventually dry land. Man-made pollution tends to hasten the process.

FACULTATIVE BACTERIA - Bacteria that can adapt themselves to growth and metabolism under aerobic or anaerobic conditions. Many organisms of interest in waste water stabilization are among this group.

FLOC - Gelatinous or amorphous solids formed by chemical, biological, or physical agglomeration of fine materials into larger masses that are more readily separated from the liquid.

FUNGI - Simple or complex organisms without chlorophyll. The simpler forms are one-celled; higher forms have branched filaments and complicated life cycles. Examples are molds, yeasts and mushrooms.

HARDNESS - Commonly refers to the chemicals interfering with soap action or producing scale in boilers or heating units. Specifically refers to Calcium and Magnesium salts; sometimes including iron, aluminum, and silica.

INDICATOR - May include the color change of a dye, electronic sensor response, or other means of estimating the equivalence point of a reaction between two different materials.

INFLUENT - That material entering a process unit or operation.

INORGANIC - Being composed of material other than plant or animal materials. Forming or belonging to the inanimate world.

LAGOON - A natural or artificial basin used for storage and/or stabilization of waste water or sludge. Sometimes used for indefinite storage for disposal purposes. Commonly the lagoon depth is greater than a wadeable depth but not greater than twenty feet.

LOAD - The load to a process is that which is contained in the inflow to that process. It may be expressed as hydraulic, oxygen demand, solids or other criteria.

MICRO ORGANISMS - Commonly an organism too small to be observed individually by the human eye without optical aid.

MG/L - A unit of concentration on a weight/volume basis: milligrams per liter. Equivalent to ppm when the specific gravity of the liquid is 1.0.

MIXING ZONE - An area where two or more substances of different characteristics blend to form a uniform mixture, i.e., chlorine application, heated water, or other discharged materials entering a water mass will show significant differences of chlorine residual, temperature or other criteria, depending upon the sampling location throughout the mixing zone and approach uniform results with respect to lateral, longitudinal, and vertical sampling positions when mixing has been completed.

MOST PROBABLE NUMBER (MPN) - A statistical method of determining microbial populations. A multiple dilution tube technique is utilized with a standard medium and observations are made for specific individual tube effects. Resultant coding is translated by mathematical probability tables into population numbers.

NITRIFICATION - The biochemical conversion of unoxidized nitrogen (ammonia and organic N) to oxidized nitrogen (usually nitrate).

NUTRIENTS -

a) Anything essential to support life.

b) Includes many common elements and combinations of them. The major nutrients include carbon, hydrogen, oxygen, nitrogen, sulfur, and phosphorus.

c) Nitrogen and phosphorus are of major concern because they tend to recycle and are hard to control.

OILS -

a) Liquid fats of animal or vegetable origin.

b) Oily or waxy mineral oils.

OXIDATION POND - A shallow basin employed for the stabilization of waste water.

OXYGEN DEPLETION - The loss of oxygen from water or sewage due to biological, chemical or physical action.

PARASITE - A living organism deriving its nutrients at the expense of another living organism, giving nothing in return.

PARSHALL FLUME - A device for estimation of the flow in an open conduit. Consists of a constructing section, a throat, and an expanding section. The throat contains a sill over which the liquid passes. The pressure change over the sill can be related to quantity of flow.

PARTS PER MILLION (PPM) - A unit of concentration signifying parts of some substances per million parts of dispersing medium. Equivalent numerically to mg/l only when the specific gravity of the solution is 1.0.

PATHOGENIC ORGANISMS - Bacterial, fungal, viral, or other organisms directly involved with diseases of plants, animals, or man, are included among this group.

pH - An index of hydrogen ion activity. Defined as the negative logarithm (base 10) of H^+ ion concentration at a given instant. On a scale of 0 to 14 pH 7.0 is neutral; pH less than 7.0 indicates a predominance of H^+ or acid ions; pH greater than 7.0 indicates a predominance of OH^- or alkaline ions.

POLLUTION - Anything appearing in water that renders it unacceptable in terms of established water quality standards. Commonly, conditions or contaminants that interfere with subsequent beneficial uses of water.

PRIMARY TREATMENT - Commonly the separation of settleable or floatable materials from carrier water. Usually preceded by pre-treatment such as coarse screens, grit separation, comminution.

SATURATION - Commonly refers to the maximum amount of any material that can be dissolved in water or other liquid at a given temperature and pressure. For oxygen, this commonly refers to a percentage saturation in terms of the saturation value, such as about 9 mg O_2/l at 20°C.

SECOND FOOT - An abbreviation for cubic foot per second. A rate term.

SECONDARY TREATMENT - Processes used to convert dissolved and colloidal materials in waste water to a form that may be separated from the water. Commonly consists of biodegradation and conversion to cell mass in a separable form with partial oxidation, such as in activated sludge, trickling filtration, or oxidation ponds.

SETTLEABLE SOLIDS -

a) Includes materials that will settle by gravity under low flow velocities.

b) Commonly expressed in terms of the volume of solids accumulating in an Imhoff cone after one hour on a volume basis.

SEWER - A pipe or conduit, generally covered, for the purpose of conveying waste waters from the point of origin to a point of treatment or discharge.

SEWERAGE SYSTEM - A system of sewers and appurtenances for the collection, transportation and pumping of used waters for a given area or basin. Any treatment device or facility and its outfall conduit are a part of the system.

SLIME-SEWAGE SLIMES - Consisting of organisms growing on waste water nutrients with the formation of mucilaginous covering, streamers or clumps. May consist of bacteria, molds, protozoa or algae.

STABILIZATION -

a) The activity proceeding along the pathway to stability.

b) In organic wastes, generally refers to oxidation via biochemical pathways and conversion to gaseous or insoluble materials relatively inert to further change.

STANDARD - Something set by authority. Having qualities or attributes required by law and defined by minimum or maximum limits of acceptability in terms of established criteria or measurable indices.

STANDARD METHODS - Methods of analysis prescribed by joint action of APHA, ASCE, AWWA, and FWPCA. Methods accepted by authority.

SUBSTRATE -

a) The base or media in which an organism lives.

b) The liquid in an activated sludge aeration tank.

SURFACTANT -

a) A chemical that, when added to water, will greatly reduce the surface tension of the solution.

b) The surface active component in a detergent mixture.

SUSPENDED SOLIDS - The concentration of insoluble materials suspended or dispersed in waste or used water. Generally expressed in mg/liter on a dry weight basis. Usually determined by filtration methods.

SYNERGISM - Refers to the action produced when two or more substances in combination have a greater effect than that produced by the additive effects of each one separately.

THERMAL POLLUTION - Refers to heated discharges to surface waterways. The largest contributor of heated discharges is associated with power production.

T.O.C. - Total Organic Carbon. A test expressing waste water contaminant concentration in terms of the carbon content.

TOTAL SOLIDS - Refer to the solids contained in dissolved and suspended form in water. Commonly determined on a weight basis by evaporation to dryness.

VELOCITY (FLOW) - A rate term expressed in terms of linear movement per unit of time. Commonly expressed in ft. per sec. (English) or cm/sec (Metric).

VOLATILE MATERIAL -

a) Refers to those chemicals having a vapor pressure low enough to evaporate from water readily at normal temperatures.

b) With reference to dry solids, the term includes loss in weight upon ignition at 600°C.

WATER QUALITY CRITERIA - Includes selected analytical measurements with limits designated to be acceptable or unacceptable in reference to water quality standards.

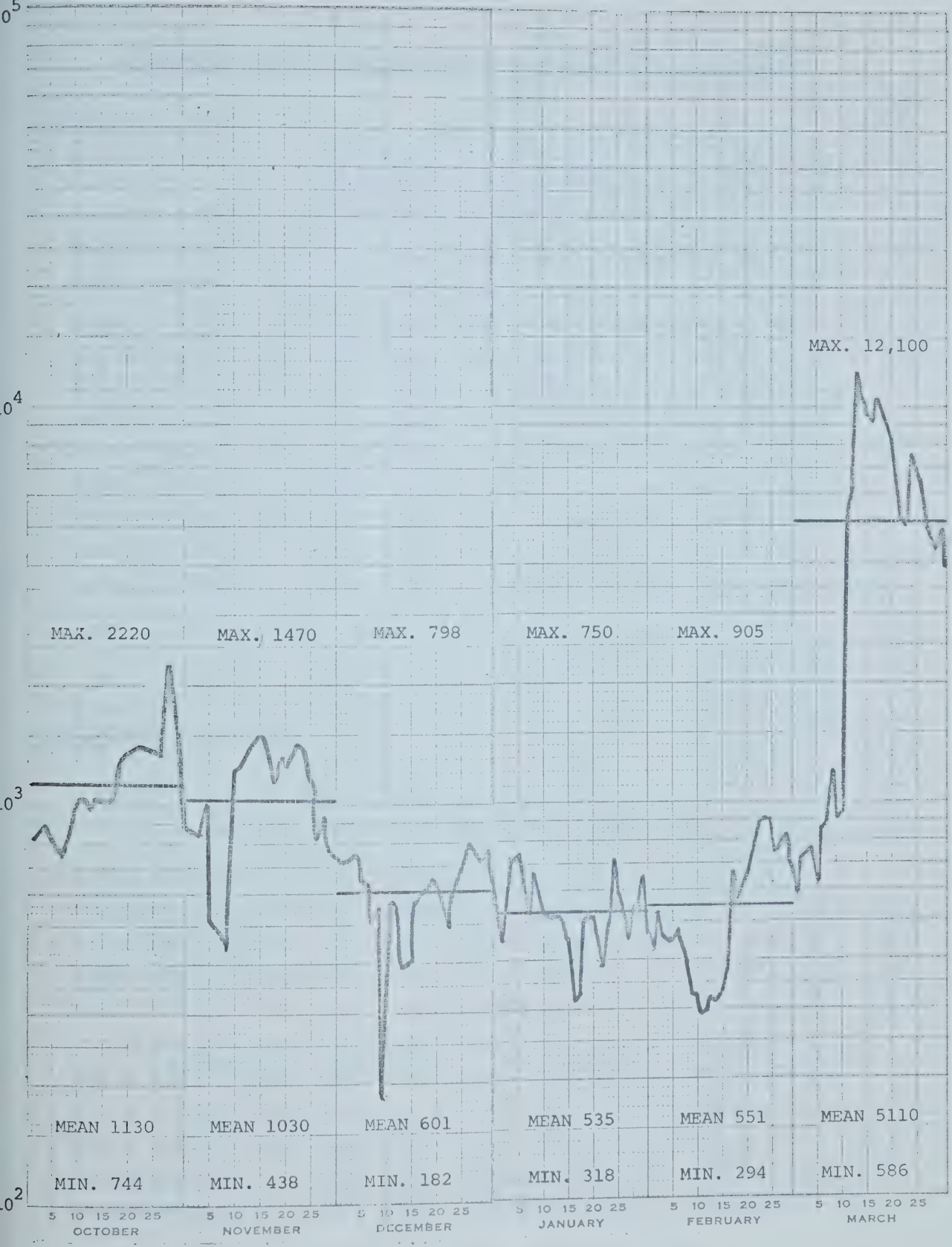
WATER QUALITY STANDARDS - Limits set by authority on the basis of water quality criteria required for beneficial uses.

WASTE WATER - Refers to the used water of a community. Generally contaminated by the waste products from household, commercial or industrial activities. Often contains surface wash, storm water and infiltrations water.

INDEX TO APPENDICES

	Page No.
APPENDIX A	
OLDMAN RIVER DAILY FLOW RATES AT LETHBRIDGE	A-1
STATISTICAL FLOW ANALYSIS OF THE OLDMAN RIVER AT LETHBRIDGE	A-2 & A-3
EFFLUENT DISCHARGERS TO THE OLDMAN RIVER AND ITS TRIBUTARIES	A-4
TOTAL LOADINGS TO THE OLDMAN RIVER	A-5
MAXIMUM, MEDIAN, AND MINIMUM VALUES FOR -	
Dissolved Oxygen	A-6
Biochemical Oxygen Demand	A-7
Phosphates	A-8
Nitrate-Nitrite Nitrogen	A-9
Ammonia Nitrogen	A-10
Total Residue	A-11
APPENDIX B	
ANALYTICAL DATA -	
Drywood Creek Below Gulf Gas Plant	B-1
Oldman River Above Lethbridge	B-2
Oldman River Above Picture Butte	B-3
Oldman River Below Picture Butte	B-4
Oldman River Above Taber	B-5
Oldman River Below Taber	B-6
RIVER CONSTITUENT PROFILES	B-7 to B-18

APPENDIX A



OLDMAN RIVER NEAR LETHBRIDGE (Station No. 05AD007)

1971-1972

STATISTICAL FLOW ANALYSIS FOR THE OLDMAN RIVER NEAR LETHBRIDGE

1957 - March 1972

THERE ARE 5296 PIECES OF DATA

THE MINIMUM FLOW IS 163 CUBIC FEET PER SECOND

1%	OF THE TIME THE FLOW IS LESS THAN	275 CUBIC FEET PER SECOND
5%	OF THE TIME THE FLOW IS LESS THAN	368 CUBIC FEET PER SECOND
10%	OF THE TIME THE FLOW IS LESS THAN	439 CUBIC FEET PER SECOND
20%	OF THE TIME THE FLOW IS LESS THAN	568 CUBIC FEET PER SECOND
30%	OF THE TIME THE FLOW IS LESS THAN	706 CUBIC FEET PER SECOND
40%	OF THE TIME THE FLOW IS LESS THAN	848 CUBIC FEET PER SECOND
50%	OF THE TIME THE FLOW IS LESS THAN	1080 CUBIC FEET PER SECOND
60%	OF THE TIME THE FLOW IS LESS THAN	1560 CUBIC FEET PER SECOND
70%	OF THE TIME THE FLOW IS LESS THAN	2520 CUBIC FEET PER SECOND
80%	OF THE TIME THE FLOW IS LESS THAN	4440 CUBIC FEET PER SECOND
90%	OF THE TIME THE FLOW IS LESS THAN	8800 CUBIC FEET PER SECOND

THE MAXIMUM FLOW IS 70,000 CUBIC FEET PER SECOND

APRIL 1971 - MARCH 1972

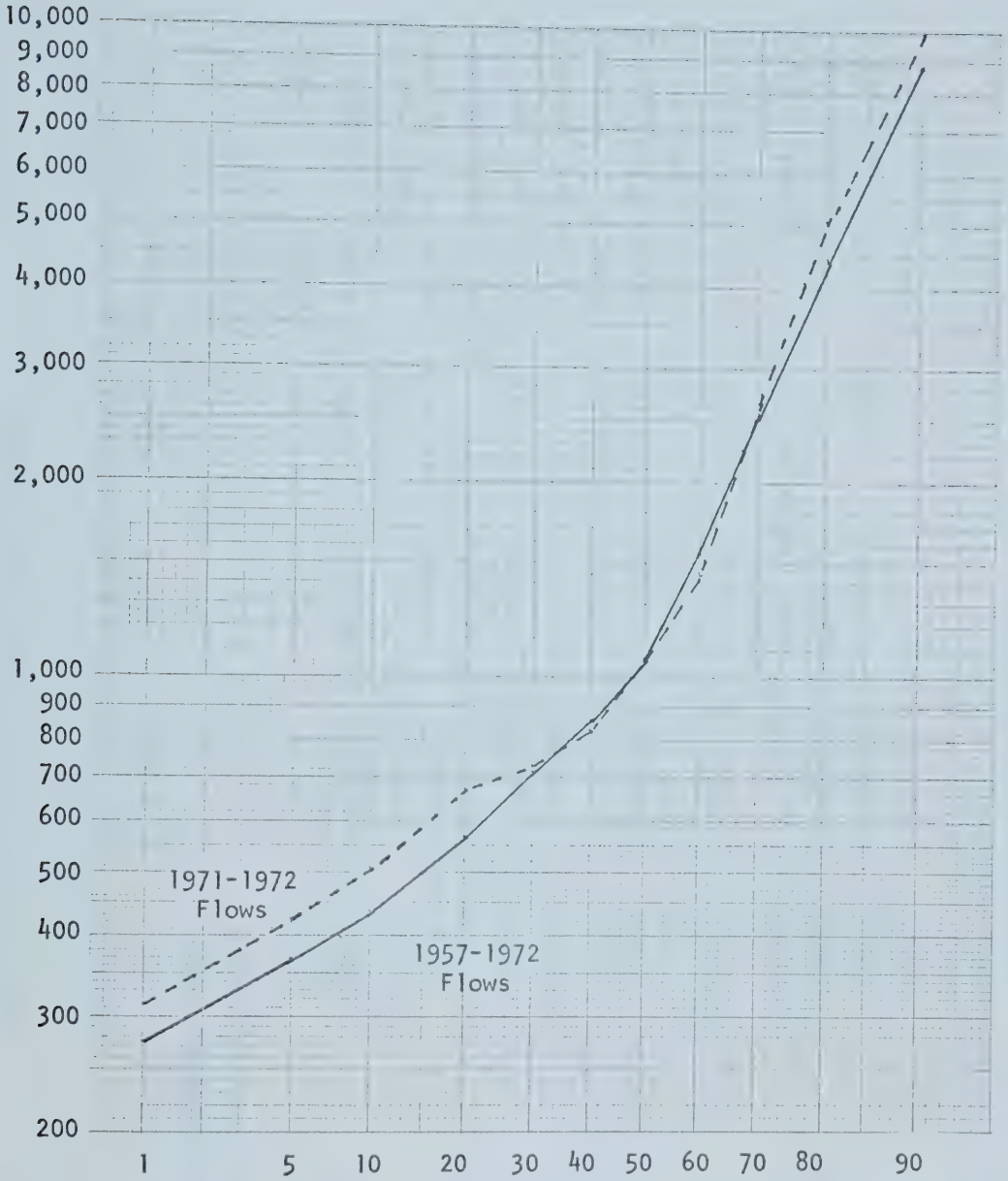
THERE ARE 366 PIECES OF DATA

THE MINIMUM FLOW IS 182 CUBIC FEET PER SECOND

1%	OF THE TIME THE FLOW IS LESS THAN	312 CUBIC FEET PER SECOND
5%	OF THE TIME THE FLOW IS LESS THAN	427 CUBIC FEET PER SECOND
10%	OF THE TIME THE FLOW IS LESS THAN	509 CUBIC FEET PER SECOND
20%	OF THE TIME THE FLOW IS LESS THAN	666 CUBIC FEET PER SECOND
30%	OF THE TIME THE FLOW IS LESS THAN	738 CUBIC FEET PER SECOND
40%	OF THE TIME THE FLOW IS LESS THAN	822 CUBIC FEET PER SECOND
50%	OF THE TIME THE FLOW IS LESS THAN	1080 CUBIC FEET PER SECOND
60%	OF THE TIME THE FLOW IS LESS THAN	1460 CUBIC FEET PER SECOND
70%	OF THE TIME THE FLOW IS LESS THAN	2650 CUBIC FEET PER SECOND
80%	OF THE TIME THE FLOW IS LESS THAN	5060 CUBIC FEET PER SECOND
90%	OF THE TIME THE FLOW IS LESS THAN	9890 CUBIC FEET PER SECOND

THE MAXIMUM FLOW IS 20,600 CUBIC FEET PER SECOND

STATISTICAL FLOW ANALYSIS OF THE OLDMAN RIVER NEAR LETHBRIDGE



FREQUENCY OF OCCURRENCE LESS THAN INDICATED (PER CENT)

1957 - March 1972	April 1971 - March 1972
Maximum Flow - 70,000 c.f.s.	Maximum Flow - 20,600 c.f.s.
Minimum Flow - 163 c.f.s.	Minimum Flow - 182 c.f.s.

EFFLUENT DISCHARGERS TO THE OLDMAN RIVER AND ITS TRIBUTARIES

Source	Type of Waste and Treatment	Discharged to
Coleman	Domestic - Oxidation Ditch	Crowsnest
Blairmore	Domestic - Oxidation Ditch	Crowsnest
Pincher Creek	Domestic - Lagoon 2S, 2L	Pincher Creek - Oldman River
Gulf Oil - Pincher Creek	Industrial & Domestic - Lagoon 1L	Drywood Creek
Shell - Waterton	Industrial & Domestic - Lagoon (extended aeration)	Drywood Creek
Fort McLeod	Domestic - Primary	Oldman River
Cardston	Domestic - Lagoon 4S	St. Mary River
Magrath	Domestic - Total Oxidation	Pothole Creek - St. Mary River
Lethbridge	Municipal - Secondary	Oldman River
Picture Butte	Domestic - IMHOFF Tank	Oldman River
Canadian Sugar Factories - Picture Butte	Seasonal Industrial - Screening with lime cake removal	Oldman River
Taber	Municipal - Lagoon 2S, 1L	Oldman River
Canadian Sugar Factories - Taber	Seasonal Industrial - Screening with lime cake removal	Oldman River

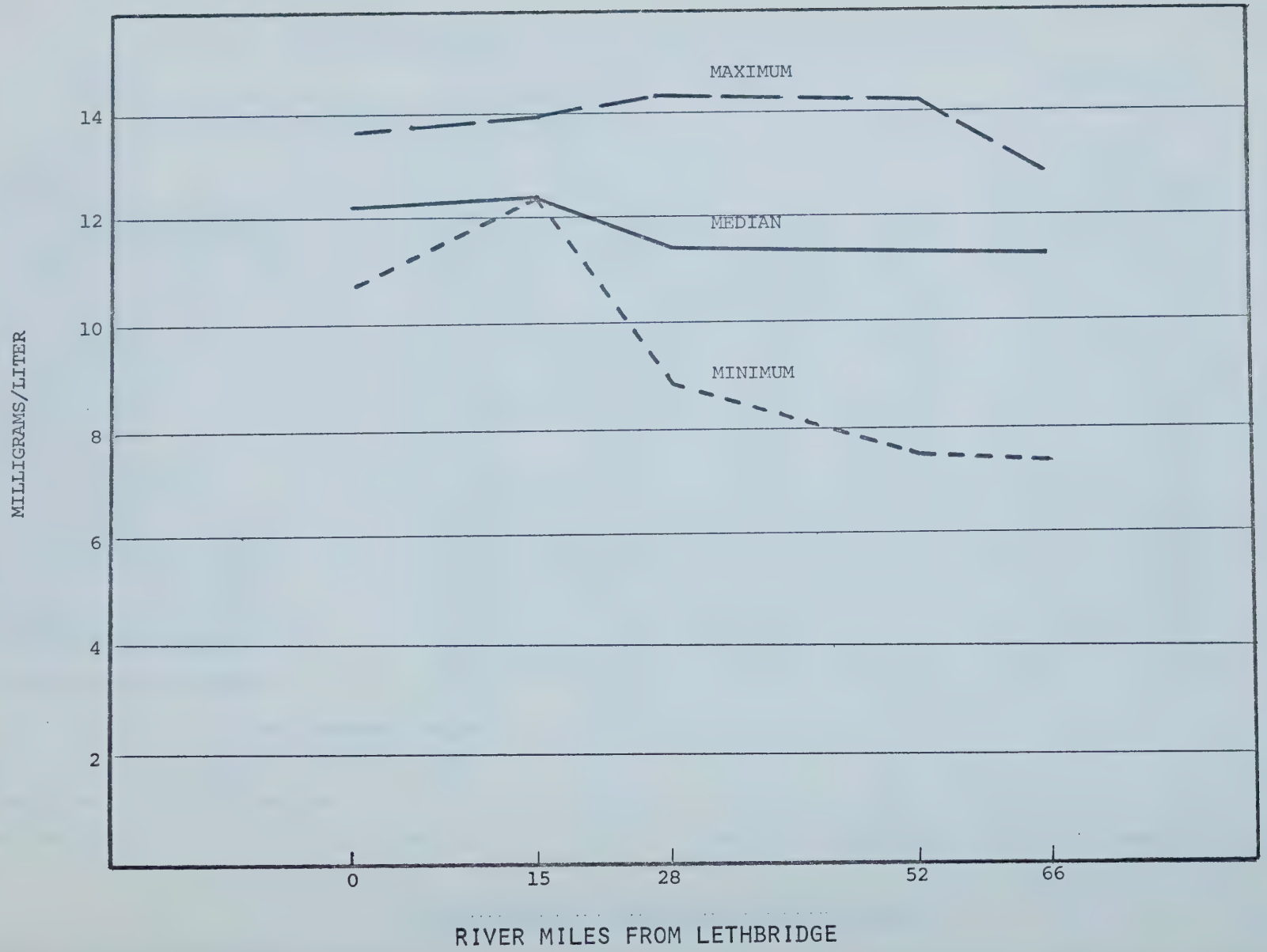
S = Short Detention Lagoon

L = Long Detention Lagoon

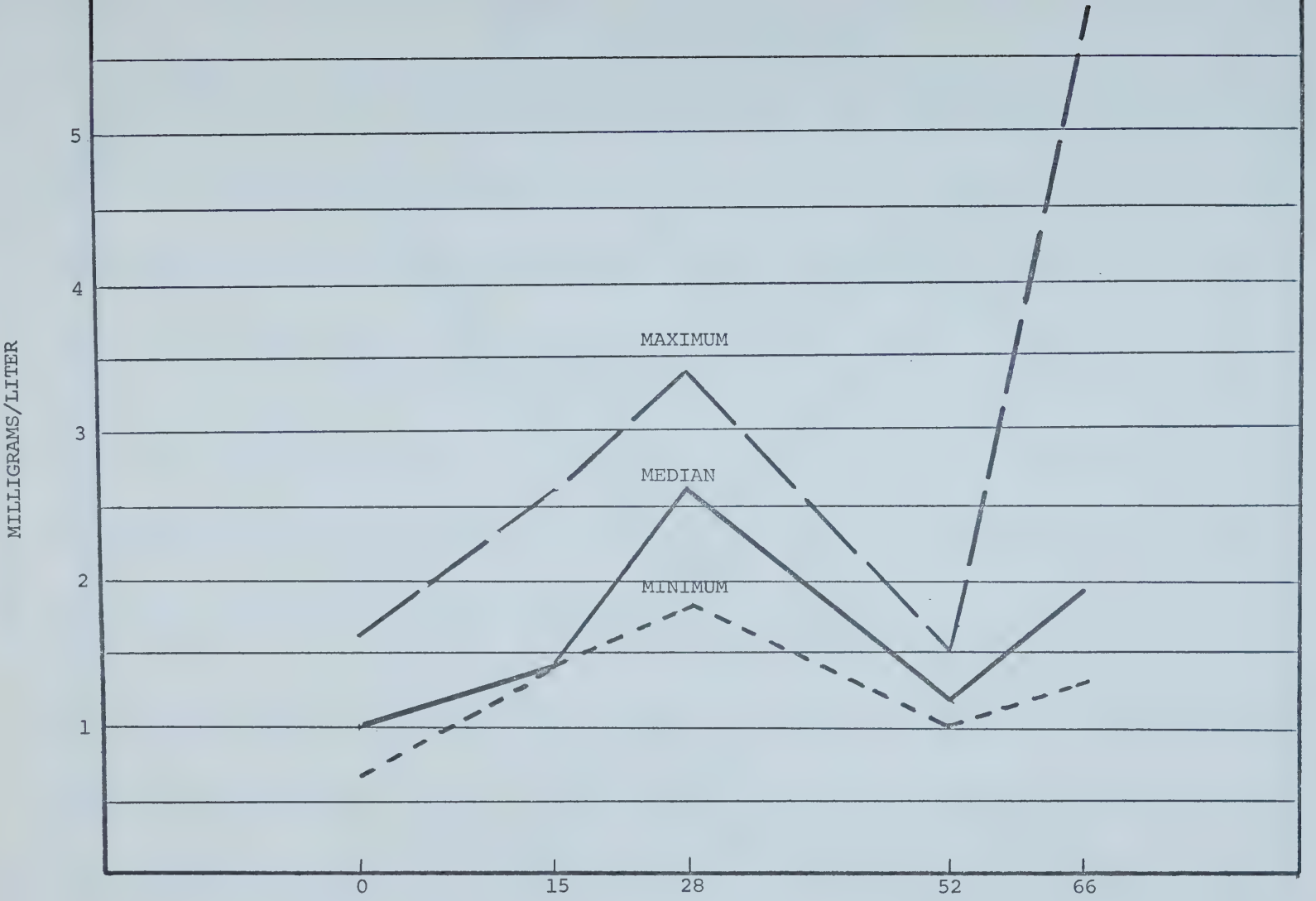
TOTAL LOADINGS TO THE OLDMAN RIVER (lbs/day)

Sampling Date	Sept.20/71	Oct.19/71	Nov.9/71	Nov.30/71	Jan.18/72	Feb.22/72	Mar.21/72
River Flow c.f.s. (Lethbridge)	783	1,020	948	721	502	842	6,000
No. of Locations Sampled	2	5	5	5	2	1	1
BIOCHEMICAL OXYGEN DEMAND	29,600	52,644	71,506	64,138	3,935	18,443	5,880
CHEMICAL OXYGEN DEMAND	46,100	89,167	102,943	114,795	4,850	56,648	8,820
ALKALINITY p.p. as $CaCO_3$	0	0	0	0	0	0	0
TOTAL ALKALINITY as $CaCO_3$	10,600	47,293	50,929	33,789	9,635	15,479	12,740
TOTAL RESIDUE	44,810	312,153	620,125	274,777	28,170	57,570	48,314
IGNITION LOSS	21,000	62,675	104,609	59,007	4,950	7,772	14,700
NON-FILTRABLE RESIDUE	11,350	231,987	540,167	199,870	1,146	5,928	3,675
IGNITION LOSS	10,650	35,457	88,931	38,300	628	5,137	2,940
AMMONIA NITROGEN	1,090	3,102	3,932	6,130	1,045	1,120	2,450
NITRATE NITROGEN	0	53.8	20.4	13.9	3.5	6.6	9.8
OIL AND GREASE	4,880	2,417*	3,640*	2,520*	633	-	-
PHENOLICS	1.9	6.4*	1.8*	2.4*	0.3	2.1	1.5
CHLORIDES	2,400	6,761	6,538	6,115	4,542	12,778	6,860
TOTAL PHOSPHOROUS as PO_4	1,775	2,799*	1,682*	1,708*	1,204	507	1,632
SULPHATES	-	-	-	-	5,125	1,976	-

* No values for the two sugar factories.

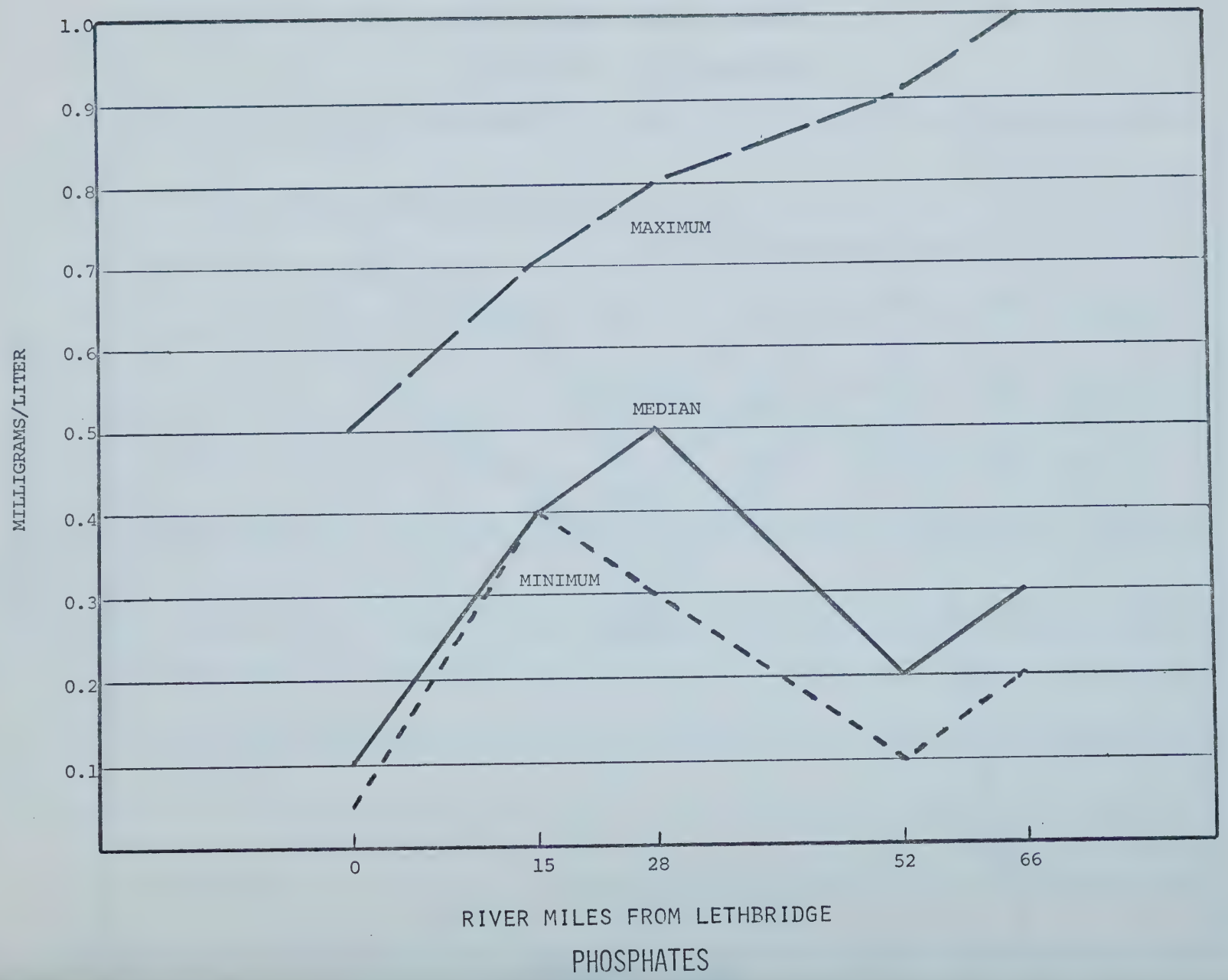


DISSOLVED OXYGEN

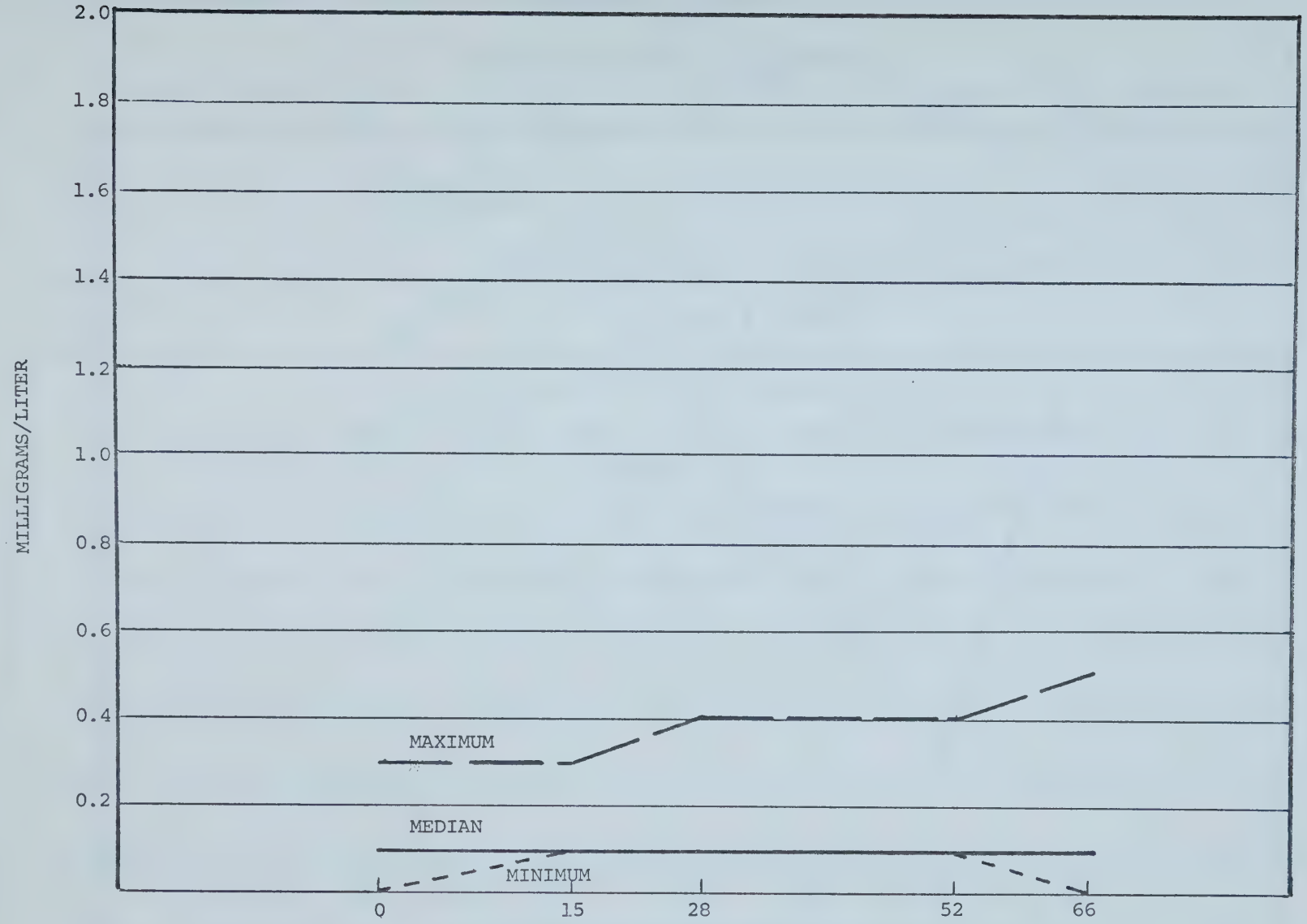


BIOCHEMICAL OXYGEN DEMAND

1971-1972 OLDMAN RIVER SURVEY

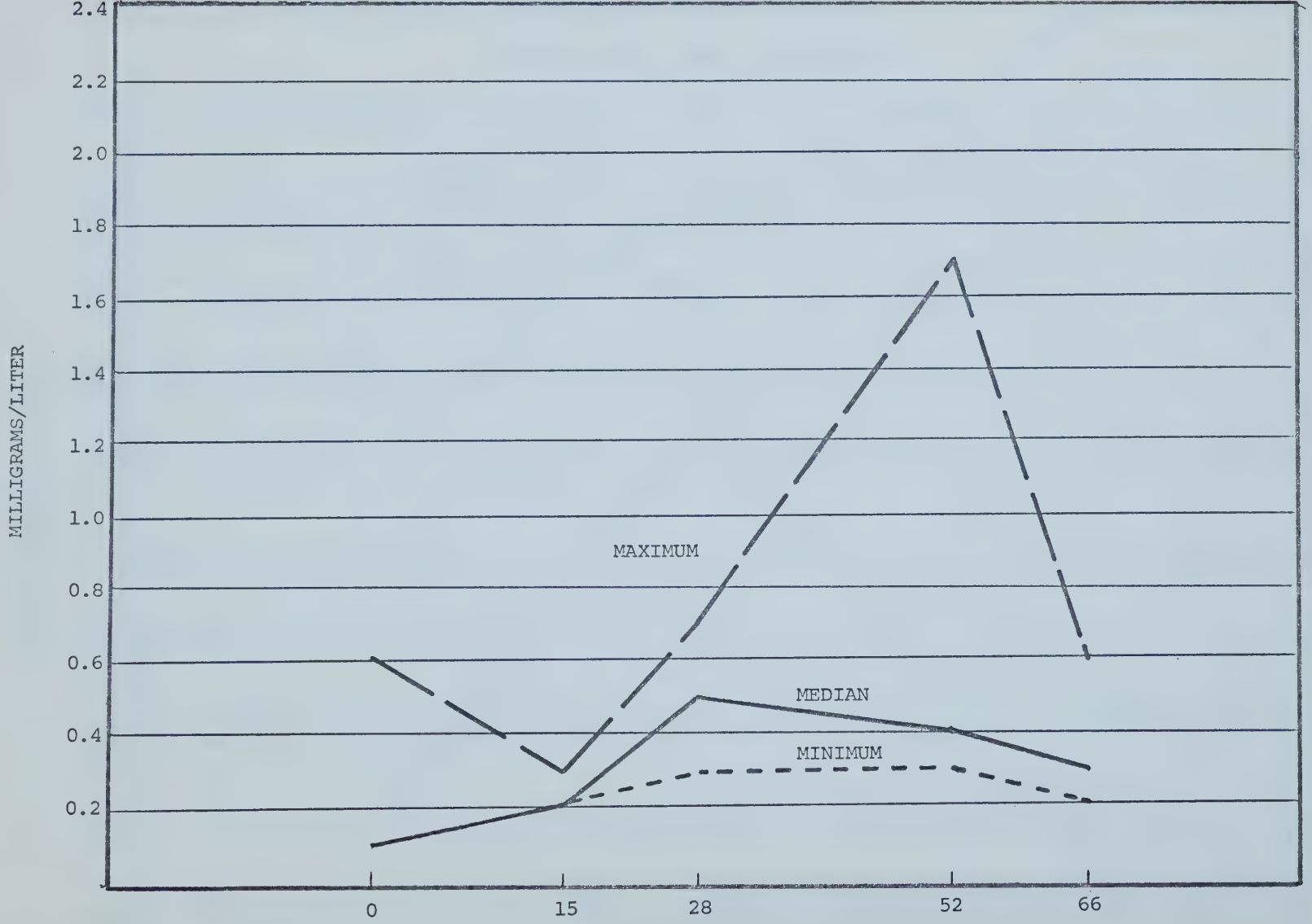

1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
MILLIGRAMS/LITER
MAXIMUM
MEDIAN
MINIMUM
0
15
28
52
66
RIVER MILES FROM LETHBRIDGE

PHOSPHATES

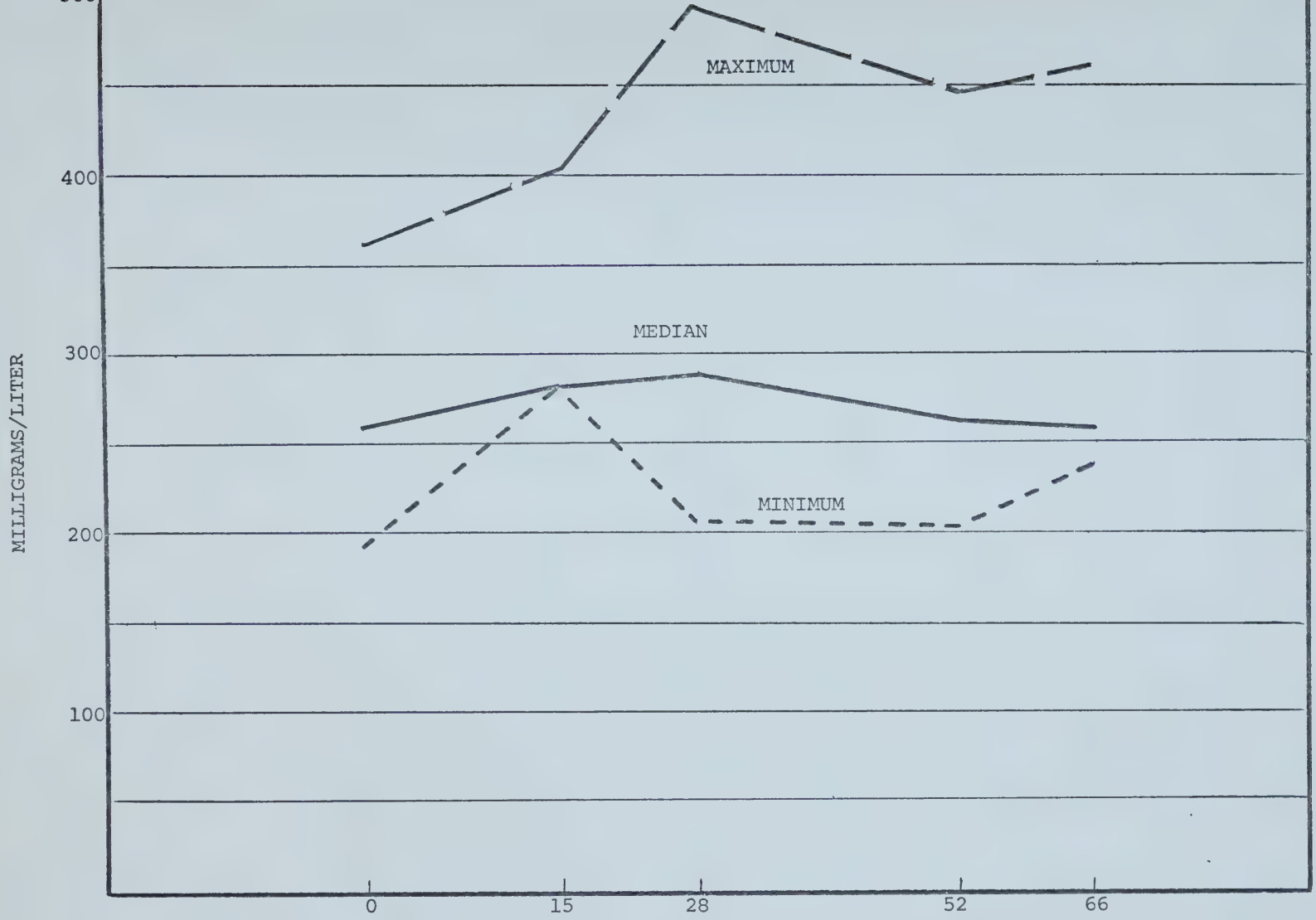


NITRATE-NITRITE NITROGEN

1971-1972 OLDMAN RIVER SURVEY



AMMONIA NITROGEN



TOTAL RESIDUE

1971-1972 OLDMAN RIVER SURVEY

APPENDIX B

WATER QUALITY DATA

CLEMAN RIVER DATA

STATION 00AT05AD2010 LATITUDE 49D 18M 30S LONGITUDE 113D 59M 40S

DRYWOOD CREEK BELOW GULF GAS PLANT

SAMPLE DATE MST D M Y	TIME H M	02061F TEMPERATURE DEG.C.	08101L OXYGEN DISSOLVED O2 MG/L	08202L OXYGEN BIOCHEMICAL DEMAND 02 MG/L	10301L PH PH UNITS	10101L ALKALINITY TOTAL CACO3 MG/L	10151L ALKALINITY PHENOL CACO3 MG/L	02601L ODOUR THRESHOLD ODOUR NUMBER T.O.N	02073L TURBIDITY TOTAL TURBIDITY UNITS
21 10 71	14 30	6	11.7	1.3	8.4	140	10.	1	2.
8 11 71	14 00		13.1	0.9	8.3	155		1	1.
30 11 71	15 30	0	13.0	1.3	8.4	175	1.	2	3.
18 1 72	15 00		12.3	2.0	8.3	185		2	3.

SAMPLE DATE MST D M Y	TIME H M	10701L SURFACTANTS ALKYL ARYL SULPHONATE MBAS MG/L	06521L OIL & GREASE O & G MG/L	06531L PHENOLIC MATERIAL MG/L	36001L COLIFORM TOTAL MPN NO/100ML	36011L COLIFORM FECAL MPN NO/100ML	30900L STANDARD PLATE COUNT BACTERIAL DENSITY NO/ML	10521L VOLATILE RESIDUE TOTAL MG/L
21 10 71	14 30		0.2	0.003	350	33	120000	44
8 11 71	14 00		0.4	0.000	16	9	3000	
30 11 71	15 30		0.8	0.001	5	2	215000	
18 1 72	15 00		0.6					

SAMPLE DATE MST D M Y	TIME H M	12103L MAGNESIUM DISSOLVED MG MG/L	17201L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	11101L SODIUM DISSOLVED NA MG/L	07551L NITROGEN DISSOLVED AMMONIA N MG/L	07106L NITROGEN DISS.NITRATE & NITRITE N MG/L	15406L PHOSPHOROUS TOTAL PHOSPHATE P MG/L	16362L SULPHATE DISSOLVED SO4 MG/L
21 10 71	14 30		3.0	2.0	6.0	0.1	0.0	0.1	28.0
8 11 71	14 00		3.0	0.7	6.0	0.1	0.4	0.1	26.0
30 11 71	15 30		3.0	1.0	4.0	0.2	0.2	0.0	25.0
18 1 72	15 00	33.0	6.0			0.1	0.1	L.1	30.0

SAMPLE DATE MST D M Y	TIME H M	10471L RESIDUE TOTAL MG/L	02041L SPECIFIC CONDUCTANCE UMHO/CM	10401L RESIDUE NONFILTER. MG/L	26002L IRON TOTAL FE+2 + FE+3 FE MG/L	10605L HARDNESS TOTAL CACO3 MG/L	20101L CALCIUM DISSOLVED CA MG/L	09105L FLUORIDE DISSOLVED F MG/L
21 10 71	14 30	224.						
8 11 71	14 00	180.				190.		
30 11 71	15 30	174.				190.		
18 1 72	15 00	270.	380	6.0	L 0.1		48.0	

SAMPLE DATE MST D M Y	TIME H M	33003L ARSENIC TOTAL AS MG/L	48004L CADMIUM TOTAL CD MG/L	24004L CHROMIUM TOTAL CR MG/L	27004L COBALT TOTAL CO MG/L	29008L COPPER TOTAL CU MG/L	82005L LEAD TOTAL PB MG/L	25056L MANGANESE TOTAL MN MG/L	80002L MERCURY TOTAL HG MG/L
30 11 71	15 30	0.002	0.002	0.002	0.004	0.001	0.01	0.01	0.0005
18 1 72	15 00		0.003	0.004	0.006	0.005	0.01	0.02	L.0005

SAMPLE DATE MST D M Y	TIME H M	28004L NICKEL TOTAL NI MG/L	34003L SELENIUM TOTAL SE MG/L	30006L ZINC TOTAL ZN MG/L
30 11 71	15 30	0.005	L.005	0.004
18 1 72	15 00	0.005	0.01	0.030

STATION 00AT05AD2030 LATITUDE 49D 41M 5S LONGITUDE 112D 51M 0S

OLDMAN RIVER ABOVE LETHBRIDGE

SAMPLE DATE TIME MST D M Y H M	02061F TEMPERATURE DEG.C.	08101L OXYGEN DISSOLVED O2 MG/L	08202L OXYGEN BIOCHEMICAL DEMAND 02 MG/L	10301L PH PH UNITS	10101L ALKALINITY TOTAL CACO3 MG/L	10151L ALKALINITY PHENOL CACO3 MG/L	02091L ODOUR THRESHOLD ODOUR NUMBER T.O.N	02073L TURBIDITY TOTAL TURBIDITY UNITS
20 10 71 10 00	5	12.2	0.8	8.3	145		1	12.
9 11 71 09 00		13.5	1.3	8.3	150		2	1.
1 12 71 09 00	0	13.7	0.7	8.3	150		2	5.
19 1 72 09 30		10.8	1.0	8.3	160		2	4.
23 2 72 12 30	0	12.7	1.0	8.0	155		2	2.
22 3 72 12 00		11.6	1.6	7.8	150		1	15.

SAMPLE DATE TIME MST D M Y H M	10701L SURFACTANTS ALKYL ARYL SULPHONATE MBAS MG/L	06521L OIL & GREASE O & G MG/L	06631L PHENOLIC MATERIAL MG/L	36001L COLIFORM TOTAL MPN NO/100ML	36011L COLIFORM FECAL MPN NO/100ML	36900L STANDARD PLATE COUNT BACTERIAL DENSITY NO/ML	10521L VOLATILE RESIDUE TOTAL MG/L
20 10 71 10 00		1.5	0.006	79	22	10000	82
9 11 71 09 00		0.2	0.002	56	0	28000	
1 12 71 09 00		0.4	0.002	5	0	46800	
19 1 72 09 30	0.3	0.2	0.000	56	0	28000	
23 2 72 12 30			0.005	33	5	500	
22 3 72 12 00			0.010	140	20	3100	

SAMPLE DATE TIME MST D M Y H M	12103L MAGNESIUM DISSOLVED MG MG/L	17201L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	11101L SODIUM DISSOLVED NA MG/L	07551L NITROGEN DISSOLVED AMMONIA N MG/L	07106L NITROGEN DISS.NITRATE & NITRITE N MG/L	15406L PHOSPHORUS TOTAL PHOSPHATE P MG/L	16302L SULPHATE DISSOLVED SO4 MG/L
20 10 71 10 00		2.0	3.0	13.0	0.2	0.0	0.1	40.0
9 11 71 09 00		2.0	0.9	15.0	0.1	0.1	0.1	30.0
1 12 71 09 00		2.0	0.9	10.0	0.2	0.1	0.1	30.0
19 1 72 09 30	45.0	4.0	0.9	9.0	L.1	0.2	0.05	45.0
23 2 72 12 30	28.0	6.0			0.1	L.1	0.1	45.0
22 3 72 12 00	17.	4.0	2.7	10.0	0.6	0.3	0.5	30.0

SAMPLE DATE TIME MST D M Y H M	10471L RESIDUE TOTAL MG/L	47161F FLOW AVERAGE (DAILY) PROVISIONAL CU.FT/SEC	02041L SPECIFIC CONDUCTANCE UMHO/CM	10401L RESIDUE NONFILTER. MG/L	26002L IRON TOTAL FE+2 + FE+3 FE MG/L	10605L HARDNESS TOTAL CACO3 MG/L	20101L CALCIUM DISSOLVED CA MG/L	09105L FLUORIDE DISSOLVED F MG/L
20 10 71 10 00	230.	1280				185.		0.15
9 11 71 09 00	258.	660				190.		0.15
1 12 71 09 00	192.	666				180.		0.15
19 1 72 09 30	260.	601	325		L.1	250.	26.0	0.05
23 2 72 12 30	296.	905	340			175.	23.0	0.10
22 3 72 12 00	360.	6000				165.	38.0	0.10

SAMPLE DATE TIME MST D M Y H M	33003L ARSENIC TOTAL AS MG/L	48004L CADMIUM TOTAL CC MG/L	24004L CHROMIUM TOTAL CR MG/L	27004L COBALT TOTAL CO MG/L	29008L COPPER TOTAL CU MG/L	82005L LEAD TOTAL PB MG/L	25006L MANGANESE TOTAL MN MG/L	80002L MERCURY TOTAL HG MG/L
1 12 71 09 00	0.002	0.001	0.002	0.004	0.003	0.02	0.01	0.0050
19 1 72 09 30		0.002	0.006	0.004	0.004	0.01	0.00	L.0005
23 2 72 12 30		0.006	0.002	0.003	0.003	0.01	0.01	L.0005
I 22 3 72 12 00		L.001	0.005	0.003	0.015	0.03	0.09	L.0005

SAMPLE DATE TIME MST D M Y H M	28004L NICKEL TOTAL NI MG/L	34003L SELENIUM TOTAL SE MG/L	30006L ZINC TOTAL ZN MG/L
1 12 71 09 00	0.005	L.005	0.011
19 1 72 09 30	0.003	0.01	0.006
23 2 72 12 30	0.003	L.01	0.065
22 3 72 12 00	0.014	L.01	0.062

STATION 00AT05AD204C LATITUDE 49D 50M 20S LONGITUDE 112D 45M 25S

OLDMAN RIVER ABOVE PICTURE BUTTE

SAMPLE DATE TIME MST D M Y H M	02061F TEMPERATURE DEG.C.	C8101L OXYGEN DISSOLVED C2 MG/L	08202L OXYGEN BIOCHEMICAL DEMAND 02 MG/L	10301L PH PH UNITS	10101L ALKALINITY TOTAL CACO3 MG/L	10151L ALKALINITY PHENOL CACO3 MG/L	02001L ODOUR THRESHOLD ODOUR NUMBER T.O.N	02073L TURBIDITY TOTAL TURBIDITY UNITS
20 10 71 11 00	5	12.4	1.4	8.2	150		1	
9 11 71 12 00		13.9	2.6	8.2			2	

SAMPLE DATE TIME MST D M Y H M	10701L SURFACTANTS ALKYL ARYL SULPHONATE MBAS MG/L	C6521L OIL & GREASE O & G MG/L	06531L PHENOLIC MATERIAL MG/L	36001L COLIFORM TOTAL MPN NO/100ML	36011L COLIFORM FECAL MPN NO/100ML	36900L STANDARD PLATE COUNT BACTERIAL DENSITY NO/ML	10521L VOLATILE RESIDUE TOTAL MG/L
20 10 71 11 00		0.1	0.004	41	13	14000	108
9 11 71 12 00		0.8	0.002	31	8	90000	

SAMPLE DATE TIME MST D M Y H M	12103L MAGNESIUM DISSOLVED MG MG/L	17201L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	11101L SODIUM DISSOLVED NA MG/L	07551L NITROGEN DISSOLVED AMMONIA N MG/L	07106L NITROGEN DISS.NITRATE & NITRITE N MG/L	15406L PHOSPHORCUS TOTAL PHOSPHATE P MG/L	16302L SULPHATE DISSOLVED SO4 MG/L
20 10 71 11 00		3.0	2.	17.	0.3	0.3	0.7	
9 11 71 12 00			1.2	17.	0.2	0.1	0.4	

SAMPLE DATE TIME MST D M Y H M	10471L RESIDUE TOTAL MG/L	02041L SPECIFIC CONDUCTANCE UMHO/CM	10401L RESIDUE NONFILTER. MG/L	26002L IRON TOTAL FE+2 + FE+3 FE MG/L	10605L HARDNESS TOTAL CACO3 MG/L	20101L CALCIUM DISSOLVED CA MG/L	09105L FLUORIDE DISSOLVED F MG/L
20 10 71 11 00	404.		172.				
9 11 71 12 00	278.		11.		185.		

STATION 00AT05AD2050 LATITUDE 49D 51M 35S LONGITUDE 112D 36M 55S

OLDMAN RIVER BELOW PICTURE BUTTE

SAMPLE DATE TIME MST	02061F TEMPERATURE	08101L OXYGEN DISSOLVED	08202L OXYGEN BIOCHEMICAL DEMAND	10301L PH	10101L ALKALINITY TOTAL	10151L ALKALINITY PHENOL	02001L ODOUR THRESHOLD	02073L TURBIDITY TOTAL
D M Y H M	DEG.C.	C2 MG/L	02 MG/L	PH UNITS	CACO3 MG/L	CACO3 MG/L	ODOUR NUMBER T.O.N	TURBIDITY UNITS
20 10 71 12 00	5	12.7	3.4	8.4	140	11.	2	
9 11 71 13 00		13.8	1.8	8.2			4	
1 12 71 11 30	0	14.4	2.9	8.4	170	1.	4	12.0
19 1 72 12 00		8.8	2.6				4	4.0
23 2 72 13 30	0	10.4	2.6	7.9	165		4	2.0
22 3 72 12 00		11.4	3.0	7.7	135		2	

SAMPLE DATE TIME MST	10701L SURFACTANTS ALKYL ARYL SULPHONATE	06521L OIL & GREASE	06531L PHENOLIC MATERIAL	36001L COLIFORM TOTAL	36011L COLIFORM FECAL	36900L STANDARD PLATE COUNT BACTERIAL	10521L VOLATILE RESIDUE TOTAL
D M Y H M	MBAS MG/L	O & G MG/L	MG/L	MPN NO/100ML	MPN NO/100ML	DENSITY NO/ML	MG/L
20 10 71 12 00		0.4	0.004	32	0	15300	82
9 11 71 13 00		0.8	0.006	1800	2	210000	
1 12 71 11 30		0.4	0.001	27	0	55000	
19 1 72 12 00			0.002	230	130	4000	
23 2 72 13 30			L.001	1800	21	9500	
22 3 72 12 00			0.015	1800	9	5700	

SAMPLE DATE TIME MST	12103L MAGNESIUM DISSOLVED	17201L CHLORIDE DISSOLVED	19101L POTASSIUM DISSOLVED	11101L SODIUM DISSOLVED	07551L NITROGEN DISSOLVED AMMONIA	07106L NITROGEN DISS.NITRATE & NITRITE	15406L PHOSPHOROUS TOTAL PHOSPHATE	16302L SULPHATE DISSOLVED
D M Y H M	MG MG/L	CL MG/L	K MG/L	NA MG/L	N MG/L	N MG/L	P MG/L	SO4 MG/L
20 10 71 12 00		2.0	2.0	16.0	0.5	0.4	0.5	
9 11 71 13 00			1.9	30.0	0.7	0.1	0.4	
1 12 71 11 30		5.0	1.2	11.0	0.6	0.1	0.3	
19 1 72 12 00	20.0	4.0	1.3	11.0	0.5	0.2	0.6	55.0
23 2 72 13 30	25.0	6.0			0.3	L.1	0.5	55.0
22 3 72 12 00	11.0	1.0	3.1	10.0	0.6	0.4	0.8	30.0

SAMPLE DATE TIME MST	10471L RESIDUE TOTAL	02041L SPECIFIC CONDUCTANCE	10401L RESIDUE NONFILTER.	26002L IRON TOTAL FE+2 + FE+3	10605L HARDNESS TOTAL	20101L CALCIUM DISSOLVED	09105L FLUORIDE DISSOLVED
D M Y H M	MG/L	UMHO/CM	MG/L	FE MG/L	CACO3 MG/L	CA MG/L	F MG/L
20 10 71 12 00	296.		79.		250.		
9 11 71 13 00	490.		76.		195.		
1 12 71 11 30	206.				190.	44.0	
19 1 72 12 00	260.	330		L.1	183.	34.0	0.05
23 2 72 13 30	284.	360		L.1			
22 3 72 12 00	415.		250.		140.	39.0	0.10

SAMPLE DATE TIME MST	33003L ARSENIC TOTAL	48004L CADMIUM TOTAL	24004L CHROMIUM TOTAL	27004L COBALT TOTAL	29008L COPPER TOTAL	82005L LEAD TOTAL	25006L MANGANESE TOTAL	80002L MERCURY TOTAL
D M Y H M	AS MG/L	CD MG/L	CR MG/L	CO MG/L	CU MG/L	PB MG/L	MN MG/L	HG MG/L
1 12 71 11 30	0.005	0.001	0.002	0.004	0.003	0.01	0.05	0.0065
19 1 72 12 00		0.002	0.006	0.004	0.004	0.00	0.01	L.0005
23 2 72 13 30		L.001	L.001	0.003	0.003	0.01	0.02	L.0005
22 3 72 12 00		0.001	0.012	0.005	0.012	0.02	0.13	L.0005

SAMPLE DATE TIME MST	28004L NICKEL TOTAL	34003L SELENIUM TOTAL	30006L ZINC TOTAL
D M Y H M	NI MG/L	SE MG/L	ZN MG/L
1 12 71 11 30	0.007	L.005	0.007
19 1 72 12 00	0.005	0.01	0.015
23 2 72 13 30	0.003	L.01	0.026
22 3 72 12 00	0.009	0.01	0.089

STATION 00AT05AG2060 LATITUDE 49D 48M 55S LONGITUDE 112D 10M 20S

OLDMAN RIVER ABOVE TAEER

SAMPLE DATE TIME MST					02061F TEMPERATURE	08101L OXYGEN DISSOLVED	08202L OXYGEN BIOCHEMICAL DEMAND	10301L PH	10101L ALKALINITY TOTAL	10151L ALKALINITY PHENOL	02001L ODOUR THRESHOLD	02073L TURBIDITY TOTAL
D	M	Y	H	M	DEG.C.	O2 MG/L	O2 MG/L	PH UNITS	CACO3 MG/L	CACO3 MG/L	ODOUR NUMBER T.O.N	TURBIDITY UNITS
20	10	71	13	30	6	13.4	1.0	8.6	140	12.0	1	15.0
9	11	71	15	00		13.5	1.5	8.2			2	2.
1	12	71	13	00	0	14.3	1.2	8.4	165	1.0	4	8.0
19	1	72	16	00	0	7.6	1.2	8.2	170		4	4.0
23	2	72	14	30	0	9.0	1.0	7.8	165		4	3.0
22	3	72	13	00		11.3	1.4	7.9	140		1	

SAMPLE DATE TIME MST					10701L SURFACTANTS ALKYL ARYL SULPHONATE	08221L OIL & GREASE	06531L PHENOLIC MATERIAL	36001L COLIFORM TOTAL	36011L COLIFORM FECAL	36900L STANDARD PLATE COUNT BACTERIAL DENSITY	10521L VOLATILE RESIDUE TOTAL
D	M	Y	H	M	MBAS MG/L	O & G MG/L	MG/L	MPN NO/100ML	MPN NO/100ML	NO/ML	MG/L
20	10	71	13	30		0.4	0.001				
9	11	71	15	00		0.8	0.010	1800	2	28000	32
1	12	71	13	00		0.5	0.005	130	4	21500	
19	1	72	16	00		0.7	0.000	40	20	12000	
23	2	72	14	30			0.001	36	2	4500	
22	3	72	13	00			0.015	1800	14	4800	

SAMPLE DATE TIME MST					12103L MAGNESIUM DISSOLVED	17201L CHLORIDE DISSOLVED	19101L POTASSIUM DISSOLVED	11101L SODIUM DISSOLVED	07551L NITROGEN DISSOLVED AMMONIA	07106L NITROGEN DISS.NITRATE & NITRITE	15406L PHOSPHOROUS TOTAL PHOSPHATE	16302L SULPHATE DISSOLVED
D	M	Y	H	M	MG MG/L	CL MG/L	K MG/L	NA MG/L	N MG/L	N MG/L	P MG/L	SO4 MG/L
20	10	71	13	30		3.0	2.0	21.0	0.4	0.3	0.20	
9	11	71	15	00			1.5	20.0	0.3	0.1	0.20	
1	12	71	13	00			1.3	14.0	0.3	0.1	0.10	
19	1	72	16	00	25.0	4.0	1.7	13.0	0.4	0.2	0.80	50.0
23	2	72	14	30	27.0	8.0			0.4	L.1	0.90	70.0
22	3	72	13	00	16.0	1.0	2.9	10.0	1.7	0.4	0.70	35.0

SAMPLE DATE TIME MST					10471L RESIDUE TOTAL	02041L SPECIFIC CONDUCTANCE	10401L RESIDUE NONFILTER.	26002L IRON TOTAL FE+2 + FE+3	10605L HARDNESS TOTAL	20101L CALCIUM DISSOLVED	09105L FLUORIDE DISSOLVED
D	M	Y	H	M	MG/L	UMHO/CM	MG/L	FE MG/L	CACO3 MG/L	CA MG/L	F MG/L
20	10	71	13	30	244.						
9	11	71	15	00	304.				210.		
1	12	71	13	00	202.				200.		
19	1	72	16	00	260.	360		L.1	215.	46.0	0.05
23	2	72	14	30	276.	345			175.	26.0	0.05
22	3	72	13	00	445.		230.		160.	38.0	0.01

SAMPLE DATE TIME MST					33003L ARSENIC TOTAL	48C04L CADMIUM TOTAL	24004L CHROMIUM TOTAL	27004L COBALT TOTAL	29008L COPPER TOTAL	82005L LEAD TOTAL	25006L MANGANESE TOTAL	80002L MERCURY TOTAL
D	M	Y	H	M	AS MG/L	CD MG/L	CR MG/L	CO MG/L	CU MG/L	PB MG/L	MN MG/L	HG MG/L
1	12	71	13	00	0.005	0.001	0.002	0.004	0.004	0.02	0.02	0.0005
19	1	72	16	00		0.002	0.006	0.004	0.008	0.01	0.02	L.0005
23	2	72	14	30		L.001	0.002	0.002	0.001	0.01	0.02	0.0005
22	3	72	13	00		L.001	0.010	0.009	0.021	0.02	0.15	L.0005

SAMPLE DATE TIME MST					28004L NICKEL TOTAL	34003L SELENIUM TOTAL	30006L ZINC TOTAL
D	M	Y	H	M	NI MG/L	SE MG/L	ZN MG/L
1	12	71	13	00	0.003	L.01	0.014
19	1	72	16	00	0.007	L.01	0.011
23	2	72	14	30	0.005	L.01	0.035
22	3	72	13	00	0.016	0.01	0.050

STATION 00AT05AG2C70 LATITUDE 49D 57M 40S LONGITUDE 112D 5M 0S

OLDMAN RIVER BELOW TABER

SAMPLE DATE TIME MST	02061F TEMPERATURE	08101L OXYGEN DISSOLVED	08202L OXYGEN BIOCHEMICAL DEMAND	10301L PH	10101L ALKALINITY TOTAL	10151L ALKALINITY PHENOL	02001L ODOUR THRESHOLD	02073L TURBIDITY TOTAL
D M Y H M	DEG.C	O2 MG/L	O2 MG/L	PH UNITS	CACO3 MG/L	CACO3 MG/L	ODOUR NUMBER T.O.N	TURBIDITY UNITS
20 10 71 15 00	3	12.5	1.9	8.4	151	18.0	1	15.
9 11 71 16 00		12.8	5.8	7.9	163		8	
1 12 71 14 30	0	12.7	4.9	8.2	175		4	14.
19 1 72 18 00	0	7.5	1.7	8.3	165		4	4.
23 2 72 15 30	0	8.5	1.3	7.6	170		2	2.
22 3 72 15 00		11.3	2.0	7.9	130		2	2.

SAMPLE DATE TIME MST	10701L SURFACTANTS ALKYL ARYL SULPHONATE	08521L OIL & GREASE	06531L PHENOLIC MATERIAL	36001L COLIFORM TOTAL	36011L COLIFORM FECAL	36900L STANDARD PLATE COUNT BACTERIAL	10521L VOLATILE RESIDUE TOTAL
D M Y H M	MBAS MG/L	O & G MG/L	MG/L	MPN NO/100ML	MPN NO/100ML	DENSITY NO/ML	MG/L
20 10 71 15 00		0.2	0.005	54	0	12800	62
9 11 71 16 00		0.8	0.009	1800	0	325000	
1 12 71 14 30	0.1	0.5	0.001	1800	0	45000	
19 1 72 18 00		0.6	0.003	48	4	670	
23 2 72 15 30	0.15		0.004	72	17	7100	
22 3 72 15 00	0.1		0.007	1800	14	4800	

SAMPLE DATE TIME MST	12103L MAGNESIUM DISSOLVED	17201L CHLORIDE DISSOLVED	19101L POTASSIUM DISSOLVED	11101L SODIUM DISSOLVED	07551L NITROGEN DISSOLVED AMMONIA	07106L NITROGEN DISS.NITRATE & NITRITE	15406L PHOSPHORUS TOTAL PHOSPHATE	16302L SULPHATE DISSOLVED
D M Y H M	MG MG/L	CL MG/L	K MG/L	NA MG/L	N MG/L	N MG/L	P MG/L	SO4 MG/L
20 10 71 15 00		1.0	2.0	17.0	0.2	0.0	0.7	40.0
9 11 71 16 00		2.0	1.9	20.0	0.3	0.1	0.2	45.0
1 12 71 14 30		3.0	2.1	16.0	0.6	0.1	0.3	60.0
19 1 72 18 00	27.0	5.0	1.6	13.0		0.2	0.45	55.0
23 2 72 15 30	24.0	9.0			0.3	L.1	0.3	80.0
22 3 72 15 00	20.0	1.0	3.1	12.0	0.5	0.5	1.0	35.0

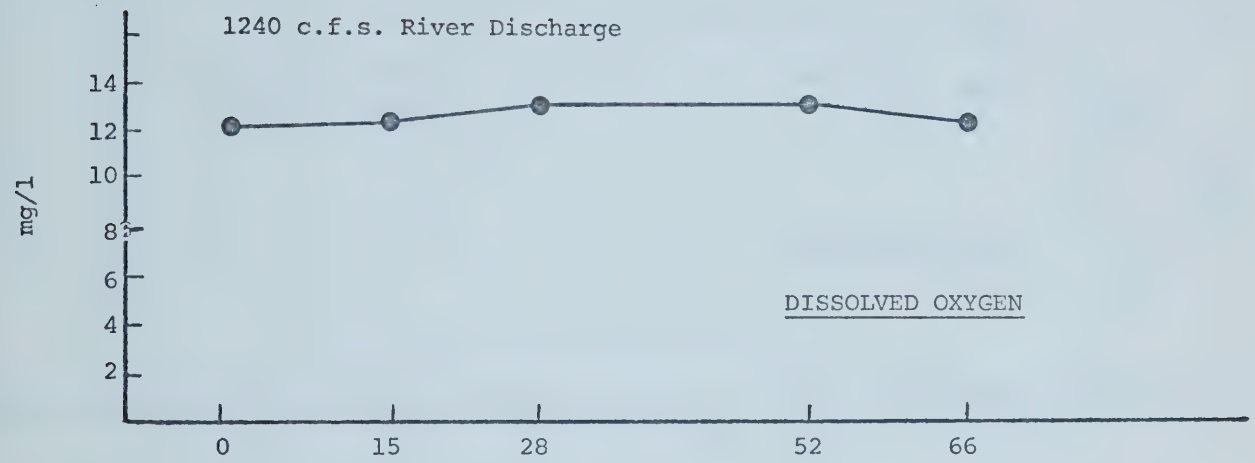
SAMPLE DATE TIME MST	10471L RESIDUE TOTAL	02041L SPECIFIC CONDUCTANCE	10401L RESIDUE NONFILTER.	26002L IRON TOTAL FE+2 + FE+3	10605L HARDNESS TOTAL	20101L CALCIUM DISSOLVED	09105L FLUORIDE DISSOLVED
D M Y H M	MG/L	UMHO/CM	MG/L	FE MG/L	CACO3 MG/L	CA MG/L	F MG/L
20 10 71 15 00	258.				235.		0.15
9 11 71 16 00	298.		34.		195.		0.10
1 12 71 14 30	240.			L.1	230.	48.0	0.05
19 1 72 18 00	250.	340			165.	25.0	0.10
23 2 72 15 30	272.	380		L.1			
22 3 72 15 00	460.		130.		175.	37.0	0.10

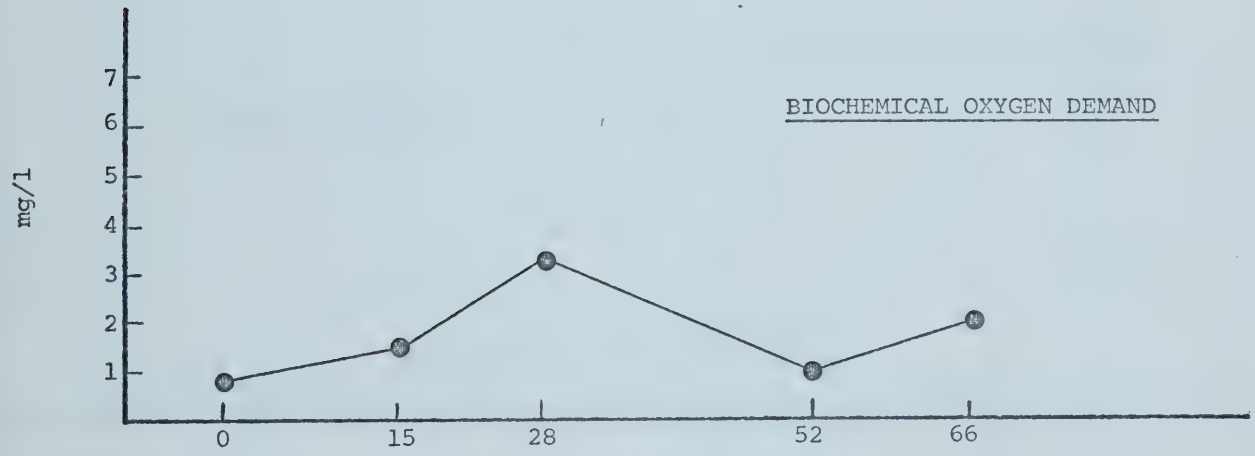
SAMPLE DATE TIME MST	33003L ARSENIC TOTAL	48004L CADMIUM TOTAL	24004L CHROMIUM TOTAL	27004L COBALT TOTAL	29008L COPPER TOTAL	82005L LEAD TOTAL	25006L MANGANESE TOTAL	80002L MERCURY TOTAL
D M Y H M	AS MG/L	CD MG/L	CR MG/L	CO MG/L	CU MG/L	PB MG/L	MN MG/L	HG MG/L
1 12 71 14 30	0.002	0.040	0.003	0.007	0.039	0.03	0.05	0.0005
19 1 72 18 00		0.002	0.006	0.004	0.016	0.01	0.03	L.0005
23 2 72 15 30		L.001	0.002	0.001	0.003	0.01	0.02	L.0005
22 3 72 15 00		L.001	0.009	0.003	0.020	0.02	0.16	L.0005

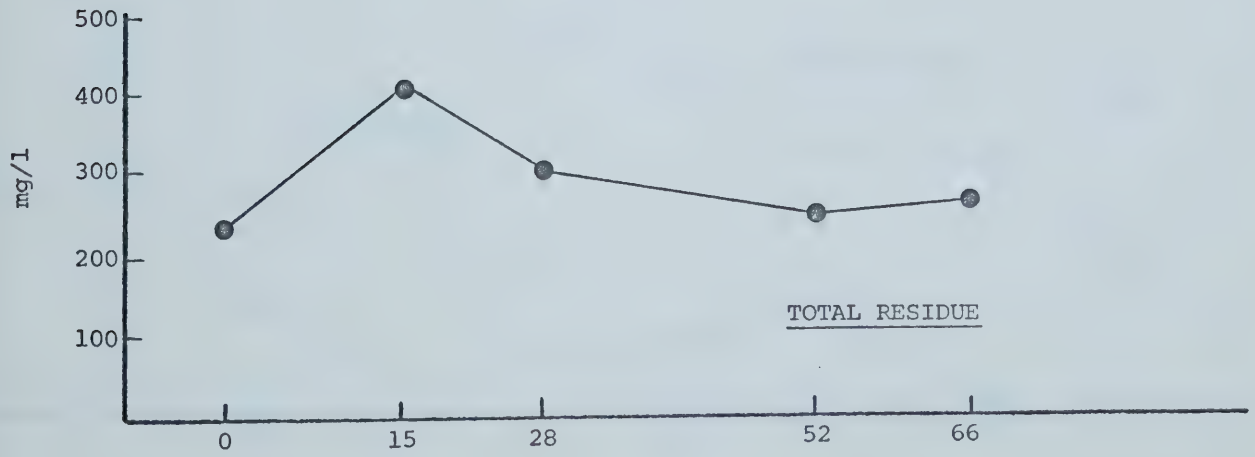
SAMPLE DATE TIME MST	28004L NICKEL TOTAL	34003L SELENIUM TOTAL	30006L ZINC TOTAL
D M Y H M	NI MG/L	SE MG/L	ZN MG/L
1 12 71 14 30	0.023	L.01	0.118
19 1 72 18 00	0.007	0.01	0.017
23 2 72 15 30	0.005	L.01	0.016
22 3 72 15 00	0.013	L.01	0.049

OLDMAN RIVER SAMPLING RESULTS

October 20, 1971





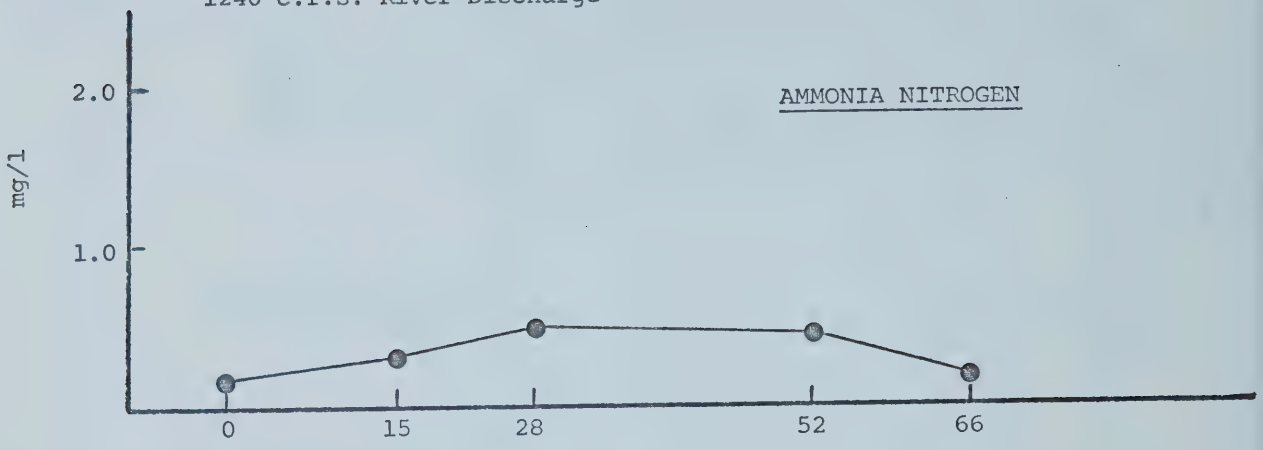


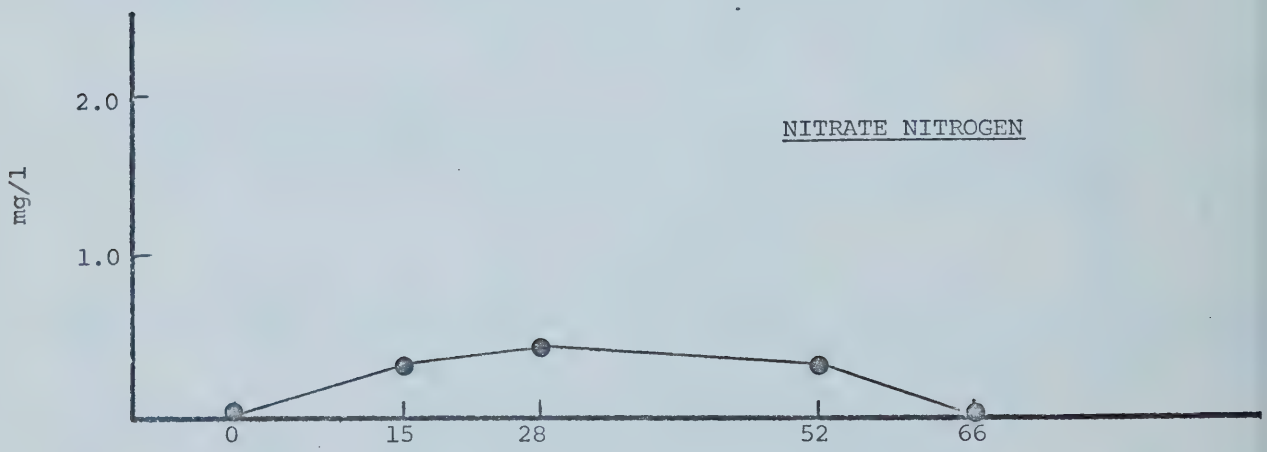
RIVER MILES FROM LETHBRIDGE

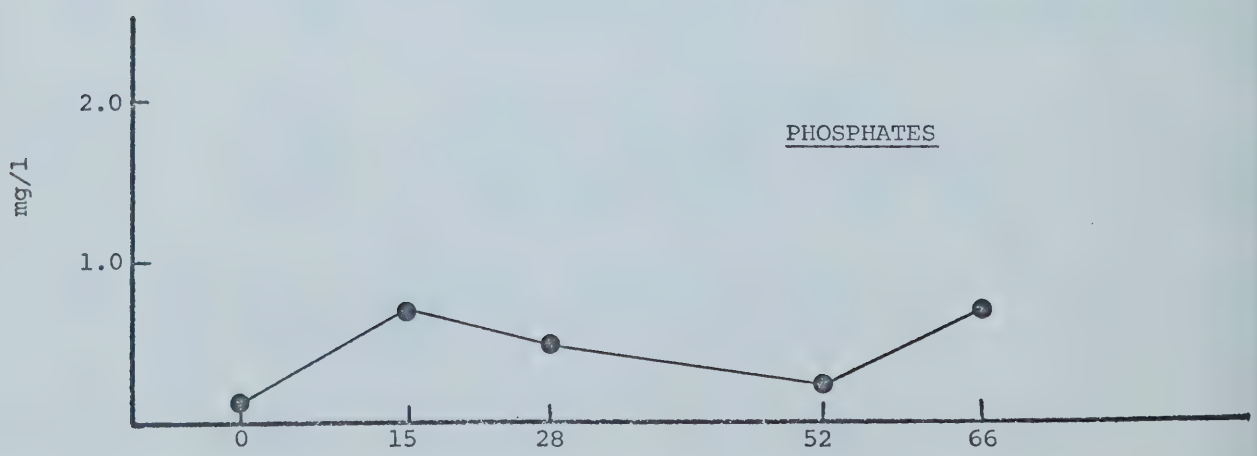
OLDMAN RIVER SAMPLING RESULTS

October 20, 1971

1240 c.f.s. River Discharge



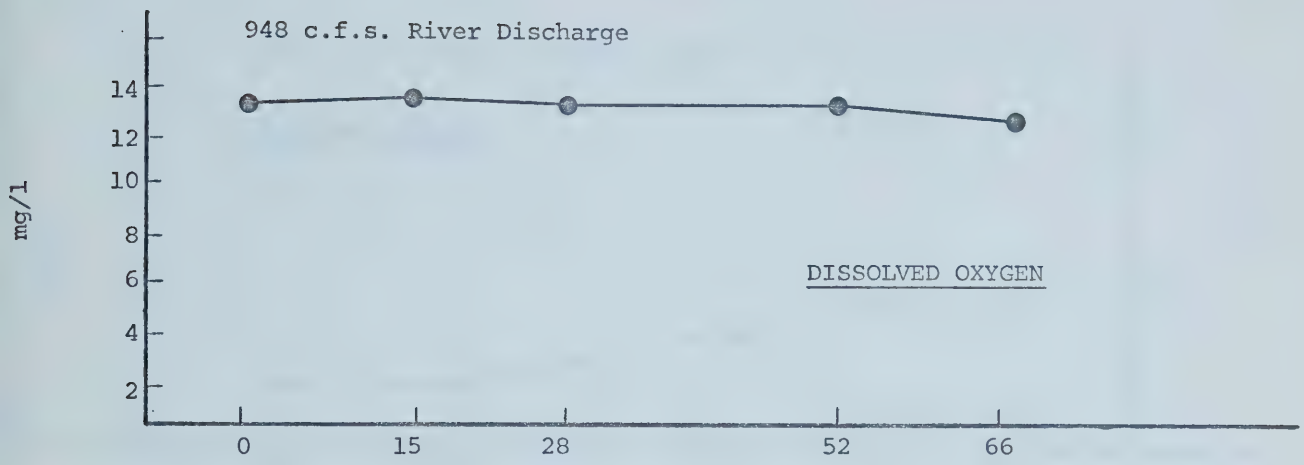


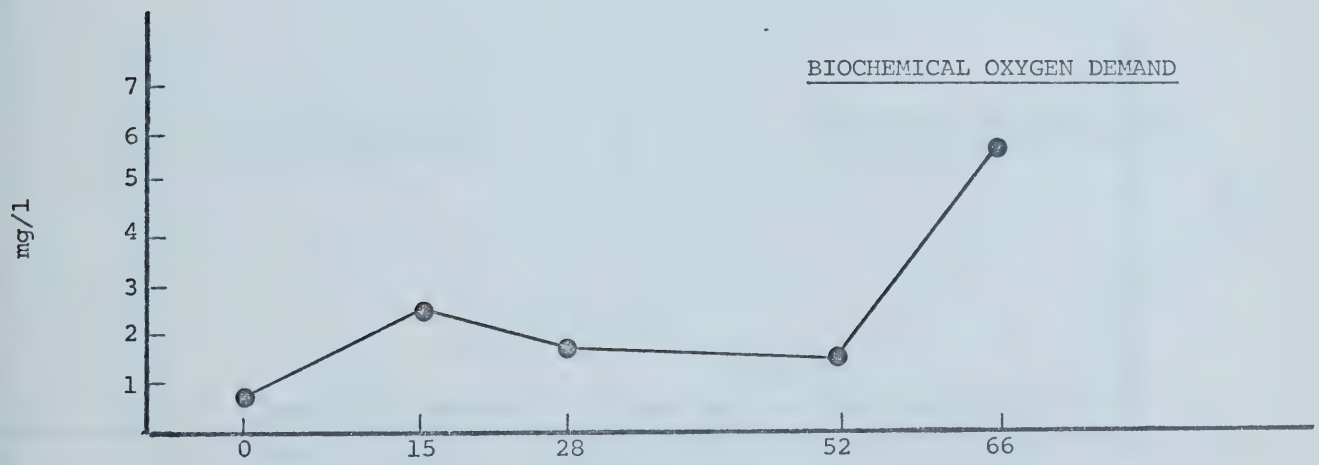


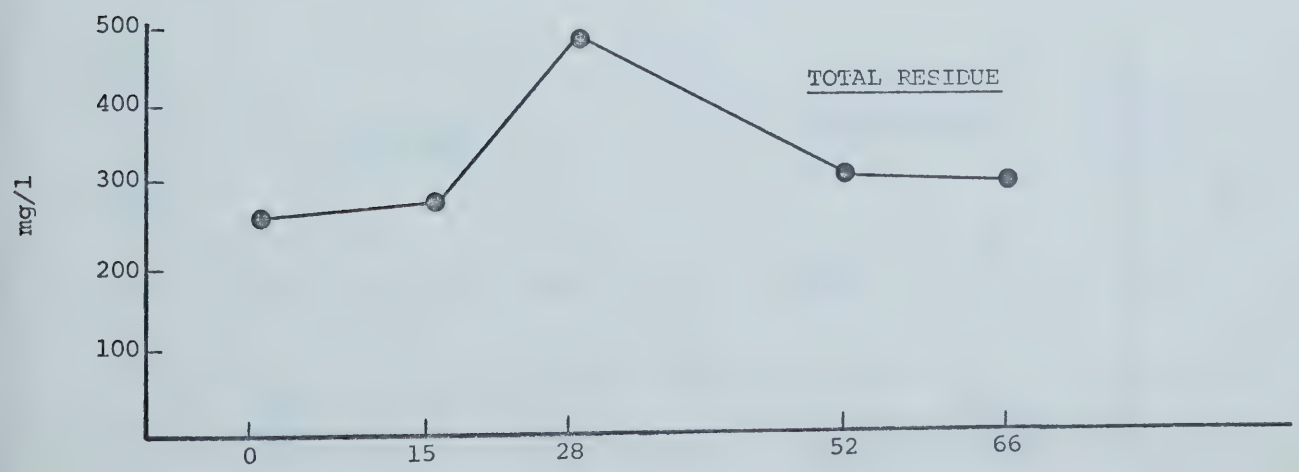
RIVER MILES FROM LETHBRIDGE

OLDMAN RIVER SAMPLING RESULTS

November 9, 1971





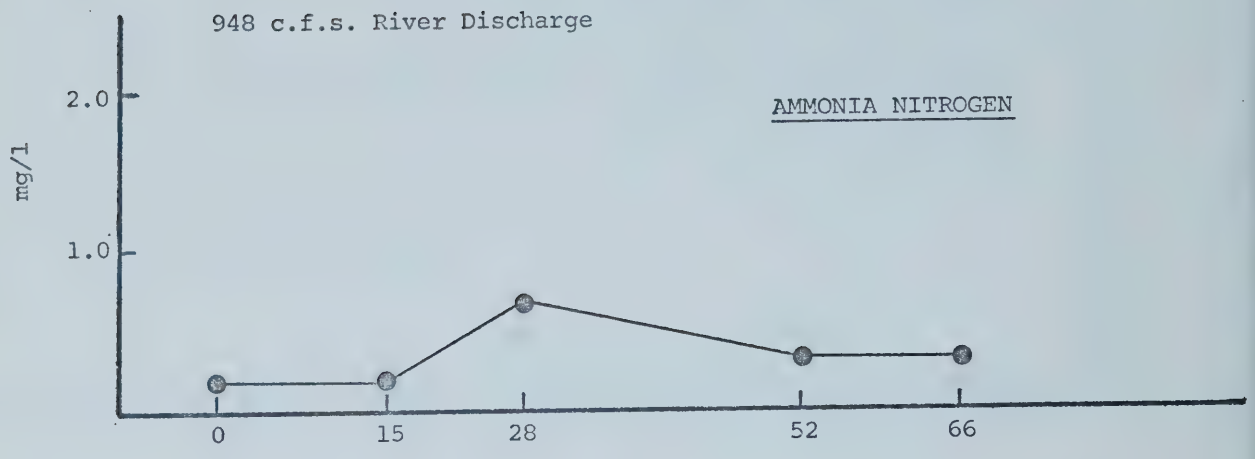


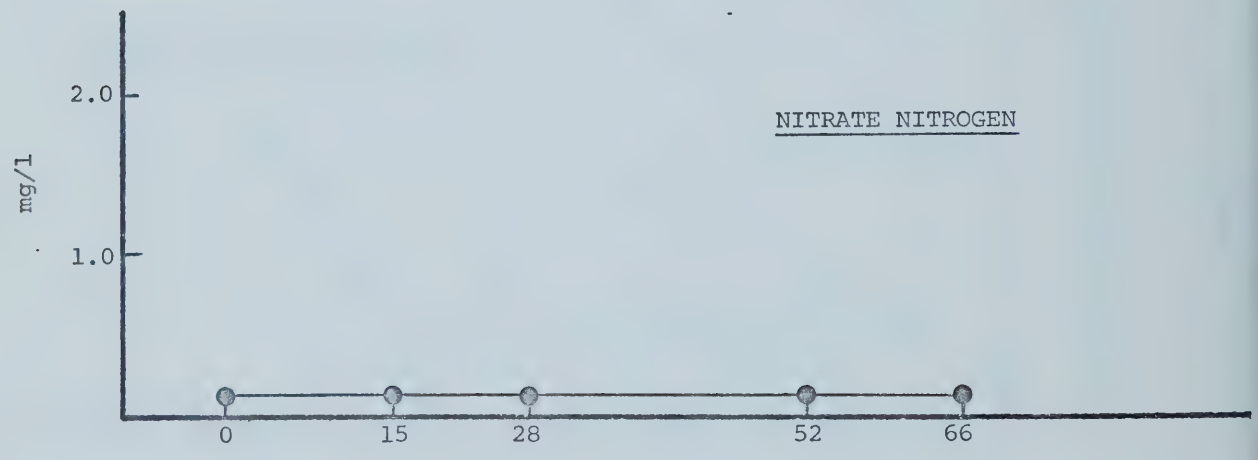
RIVER MILES FROM LETHBRIDGE

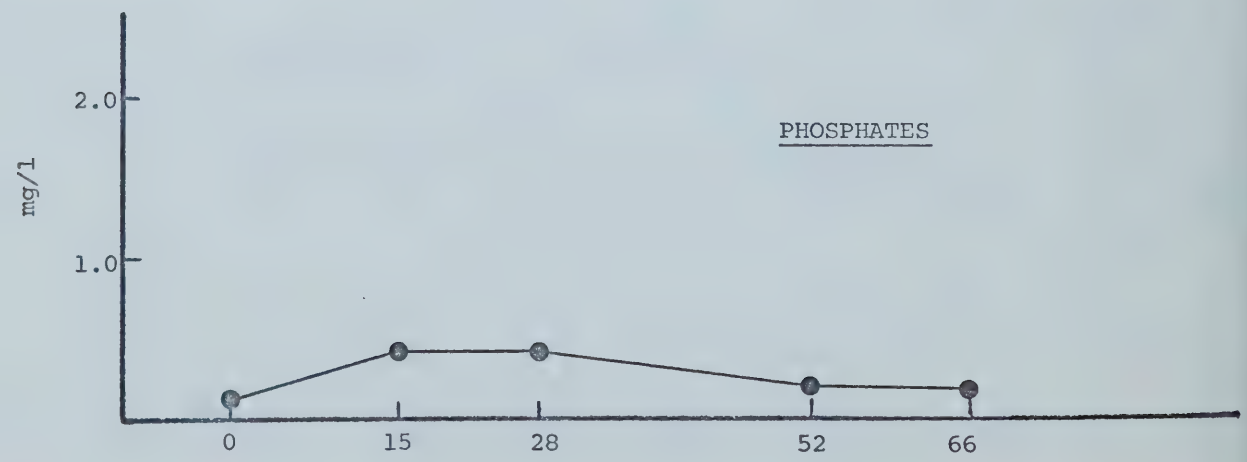
OLDMAN RIVER SAMPLING RESULTS

November 9, 1971

948 c.f.s. River Discharge



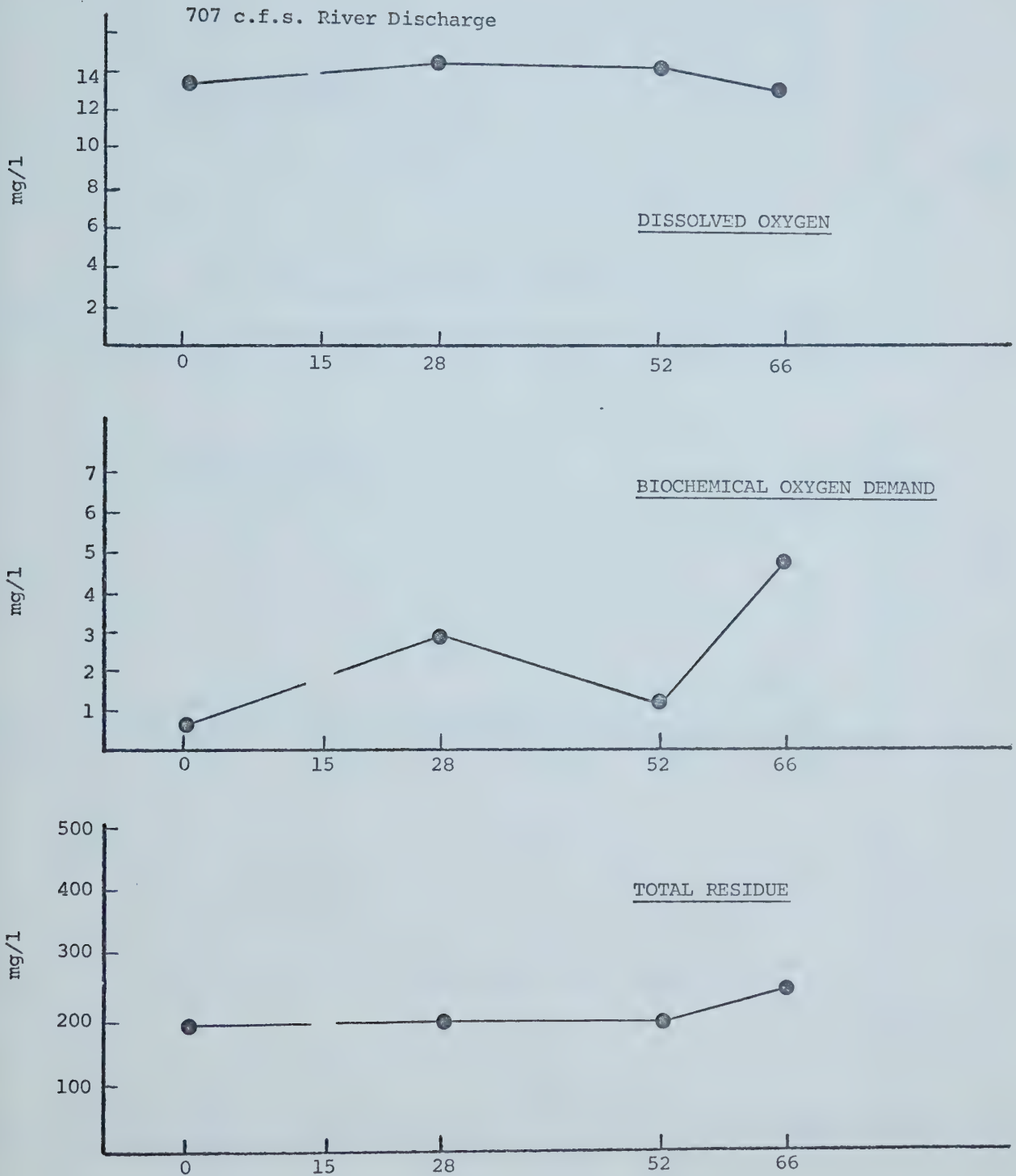




RIVER MILES FROM LETHBRIDGE

OLDMAN RIVER SAMPLING RESULTS

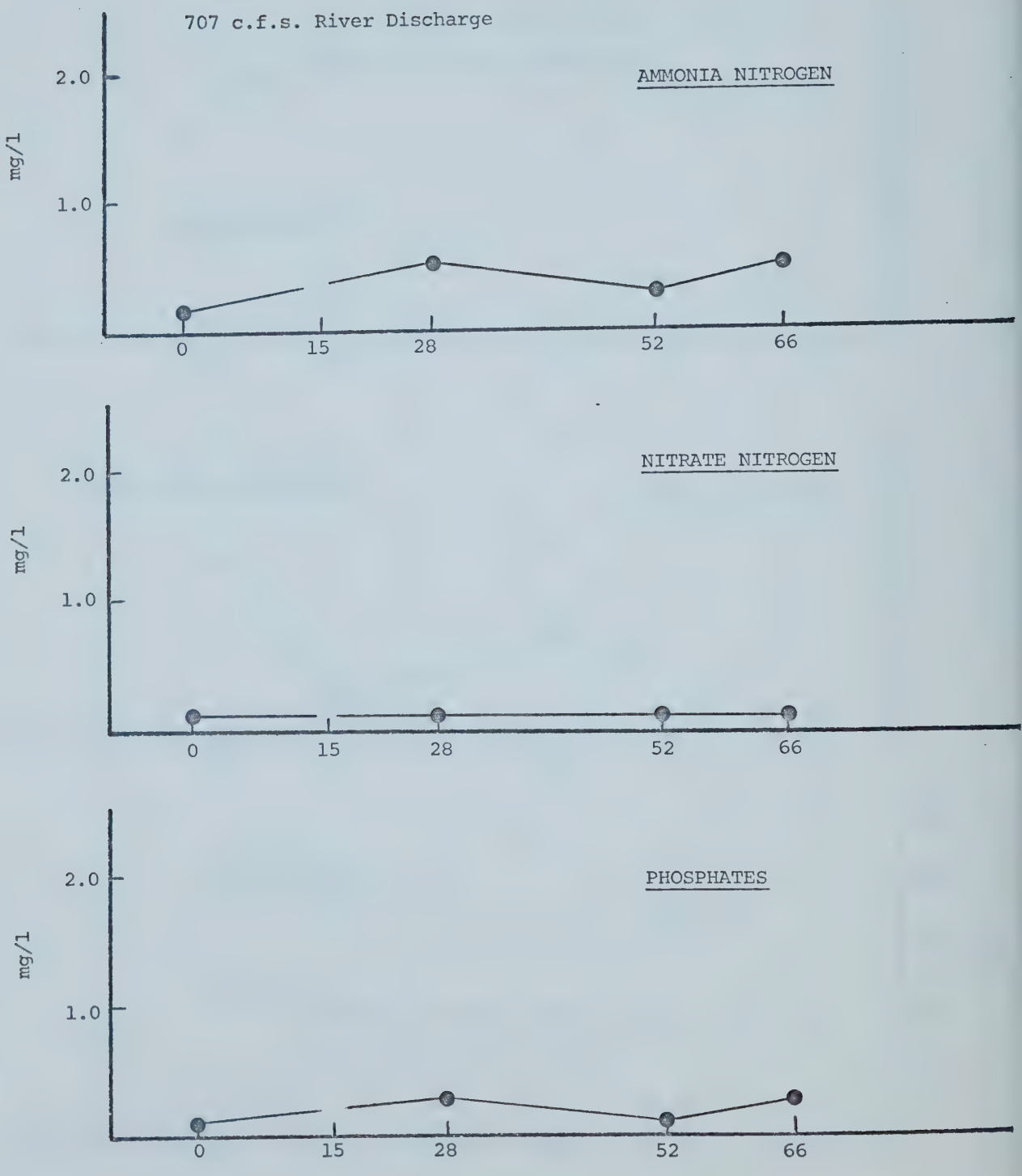
December 1, 1971



RIVER MILES FROM LETHBRIDGE

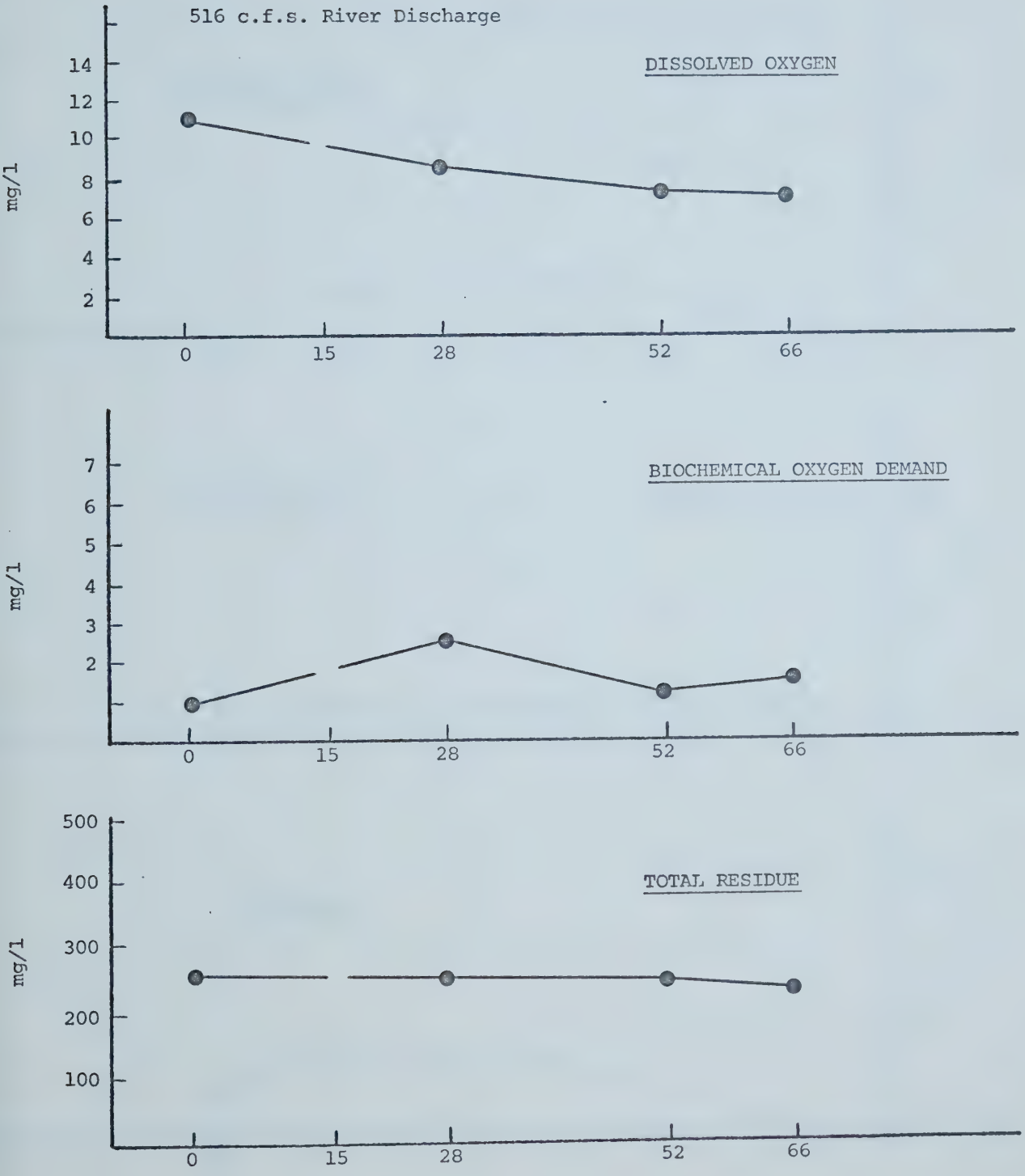
OLDMAN RIVER SAMPLING RESULTS

December 1, 1971



OLDMAN RIVER SAMPLING RESULTS

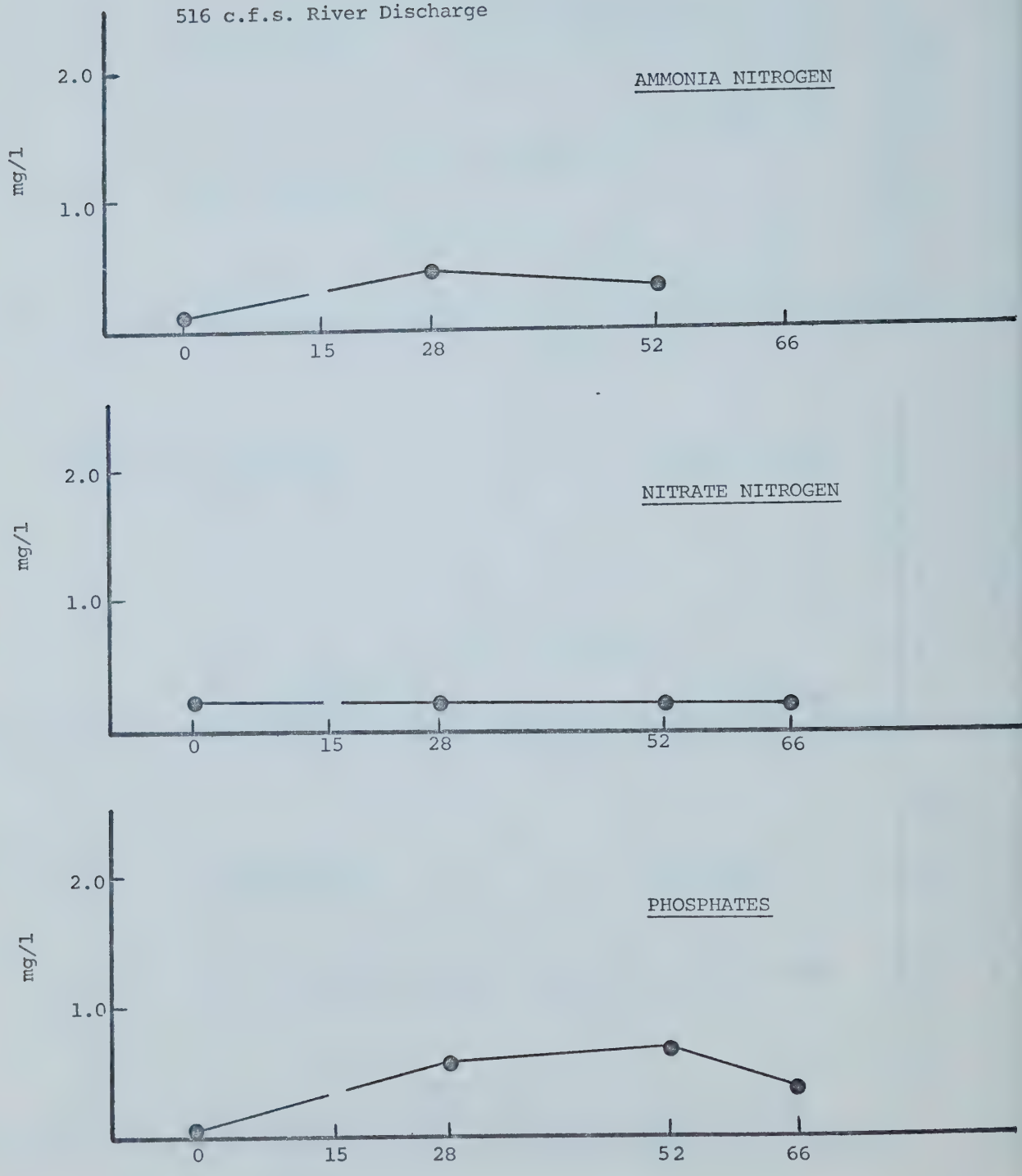
January 19, 1972



OLDMAN RIVER SAMPLING RESULTS

January 19, 1972

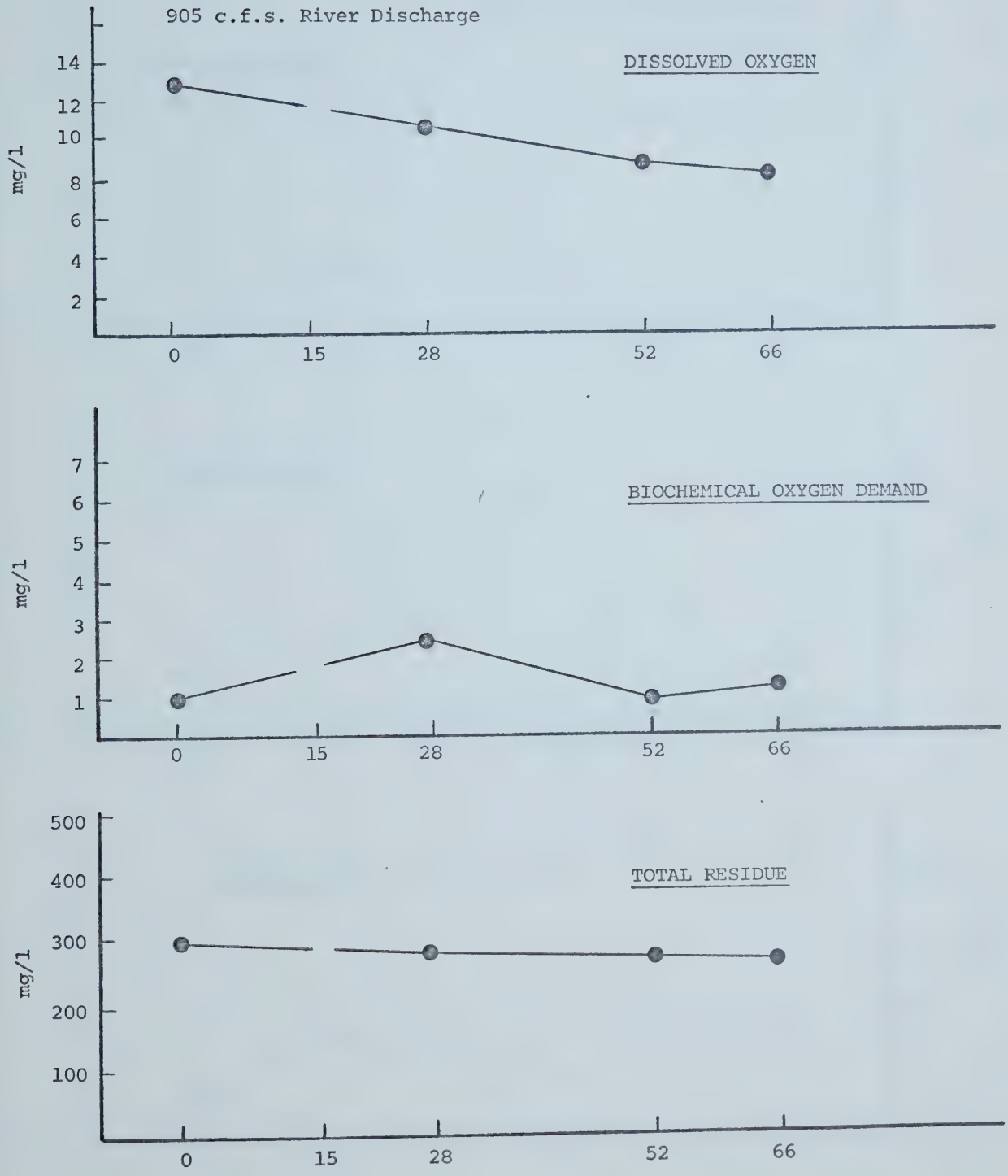
516 c.f.s. River Discharge



RIVER MILES FROM LETHBRIDGE

OLDMAN RIVER SAMPLING RESULTS

February 23, 1972

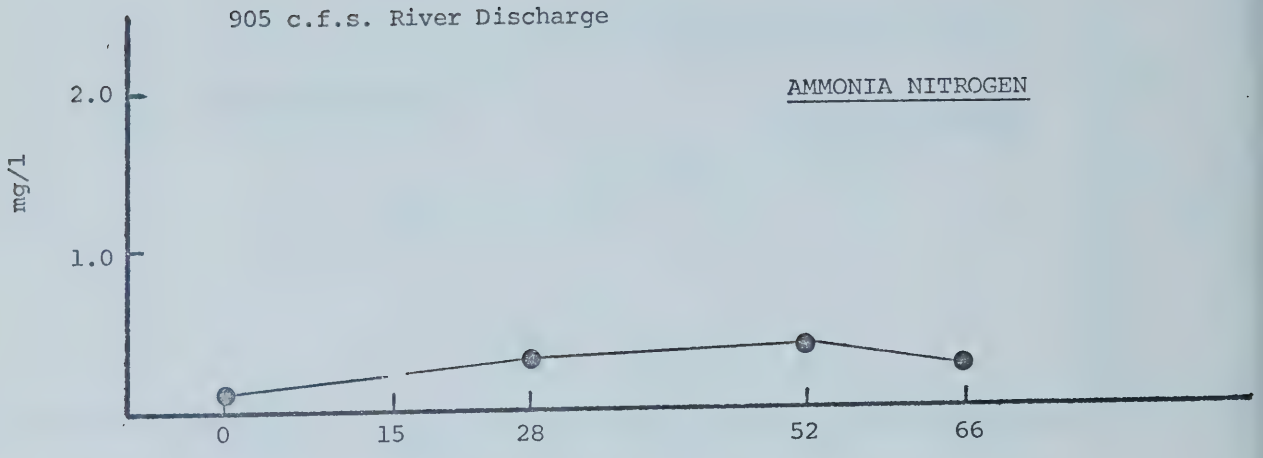


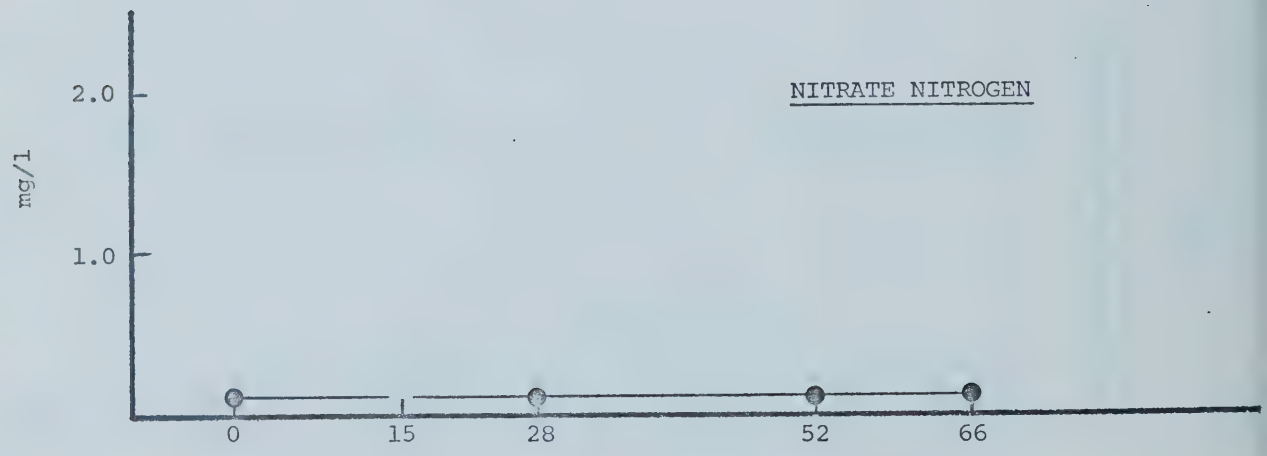
RIVER MILES FROM LETHBRIDGE

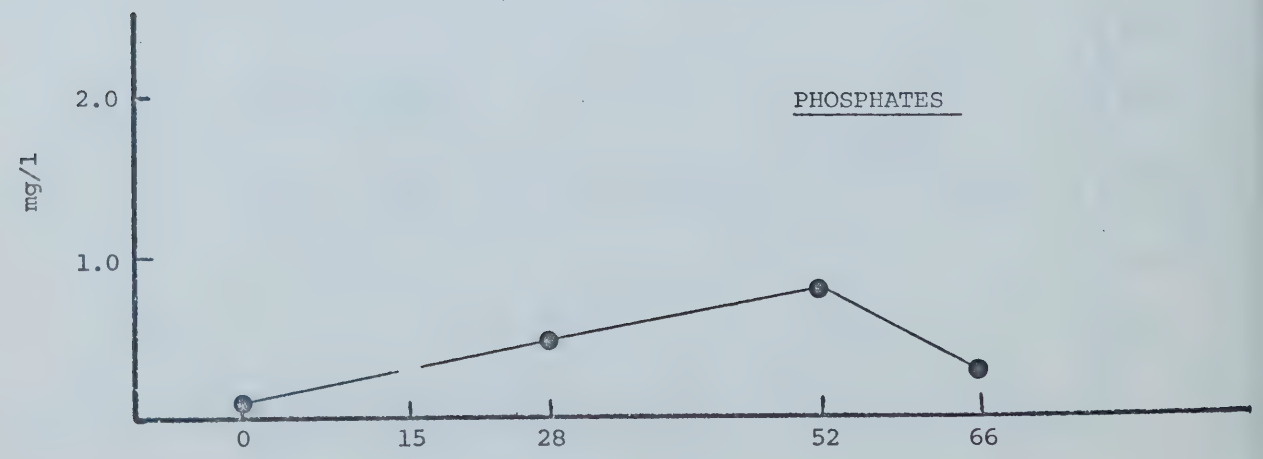
OLDMAN RIVER SAMPLING RESULTS

February 23, 1972

905 c.f.s. River Discharge



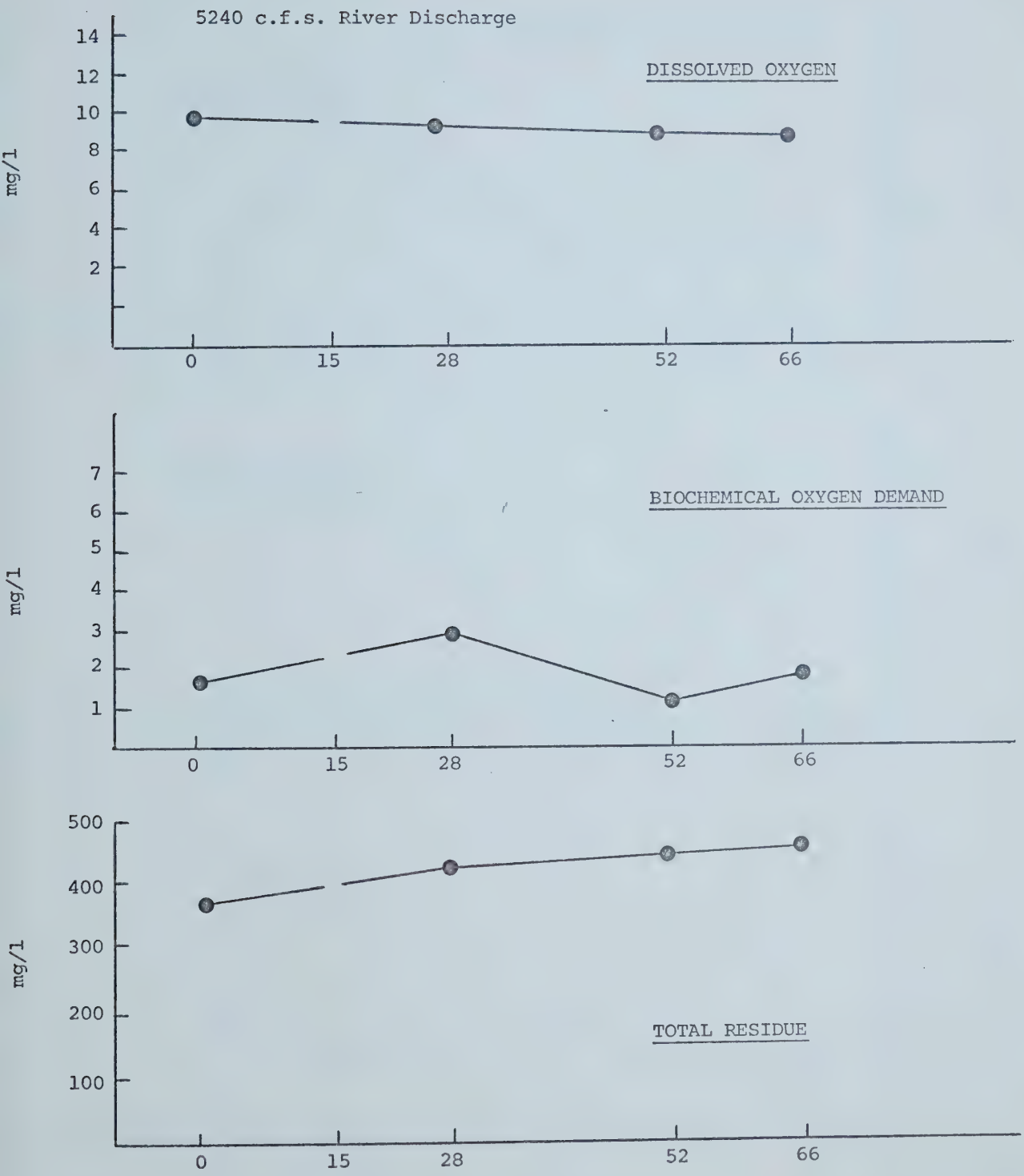




RIVER MILES FROM LETHBRIDGE

OLDMAN RIVER SAMPLING RESULTS

March 22, 1972



OLDMAN RIVER SAMPLING RESULTS

March 22, 1972